Appendix D

Echosounder Calibration Protocol

1) Background

Echosounders should ideally be calibrated prior to a survey but at least during or at the end of the survey period.

The calibration is undertaken to ensure the instrument is calibrated to the ambient (temperature / salinity) conditions of the survey and that the instrument settings have not drifted. Scientists need to use the EK80 software to calibrate, which requires an EK80 license. Once calibration is complete the resulting .xml file should be submitted alongside calibration metadata in the Acoustic Survey Metadata Form.

2) Calibration overview

(i) Stabilize the transducer, e.g. by positioning the vessel in a sheltered area using a preferred calibration site in a water depth of approximately 50-70m (see Table 1. Suggested calibration locations). Ideally calibrate during the day to avoid vertical migration of animals into the sphere location.

(ii) Measure transducer impedance (BITE test) before and after the survey to check that all sectors of the transducer are functional.

(iii) Choose an appropriate sphere for the frequency you are calibrating (Table 2).

(iv) Suspend the sphere in the transducer beam using outriggers/rods/winches and monofilament. Range from transducer face 15-20m.

(v) Measure the Temperature (T), Salinity (S) and Sound Speed (C), between the transducer and sphere. To estimate mean T, S, and C the CTD should be lowered at a rate able to collect measurements at 1m intervals.

(vi) Position the sphere in the centre of the beam, then move it throughout the beam, recording pings in the calibration wizard.

(vii) Analyse the calibration data and results.

(viii) Retrieve the sphere and stow the gear.

Table 1. Suggested calibration locations

Subarea	Calibration locations
48.1	Admiralty Bay, King George Island
48.2	Scotia Bay, Laurie Island
48.3	Stromness Bay / Rosita Harbour, South Georgia

3) Equipment required

- Monofilament line of 0.38mm (Renfree et al., 2020)
- 2 or 3 heavy, fast fishing rods or calibration winches to suspend sphere (Demer et al., 2015).
- Calibration sphere (see next)
- Solution of 25% dish washing liquid
- CTD

4) Prior to calibration

- Do a CTD to measure T, S and C.
- Calculate average T and S between 4 and 20m (or the maximum depth the sphere is likely to be) for use in calibration.
- Identify positions of transducers in relation to centre line of vessel to help guide sphere.
- Record the transducer depth.

5) Calibration spheres

- Select sphere material and diameter for your frequency and local environmental conditions. Table 1 indicates example spheres based on pulse duration of 1.024 ms, temperature = 0°C, salinity = 33.3 PSU, pressure = 25 dbar.

Check your sphere size and material for local environmental conditions at https://www.fisheries.noaa.gov/data-tools/standard-sphere-target-strength-calculator.

Table 2. Effective sphere size and materials for calibrating different frequencies of transducer, based on ambient temperature = 0°C, salinity = 33.3 PSU, pressure = 25 dbar. Green ✓ - ideal, Yellow * - use with caution as nulls within ±10 kHz, Red x – Not suitable.

Material	WC	WC	WC	WC	WC	Cu	Cu
Sphere diameter	20.0	21.0	22.0	38.1	57.2	20.0	23
38 kHz	✓	✓	✓	✓	✓	✓	✓
70 kHz	✓	✓	✓	✓	✓	✓	✓
120 kHz	✓	✓	✓	✓	*	✓	*
200 kHz	✓	✓	x	*	*	*	x

6) Procedure for getting the sphere beneath transducers

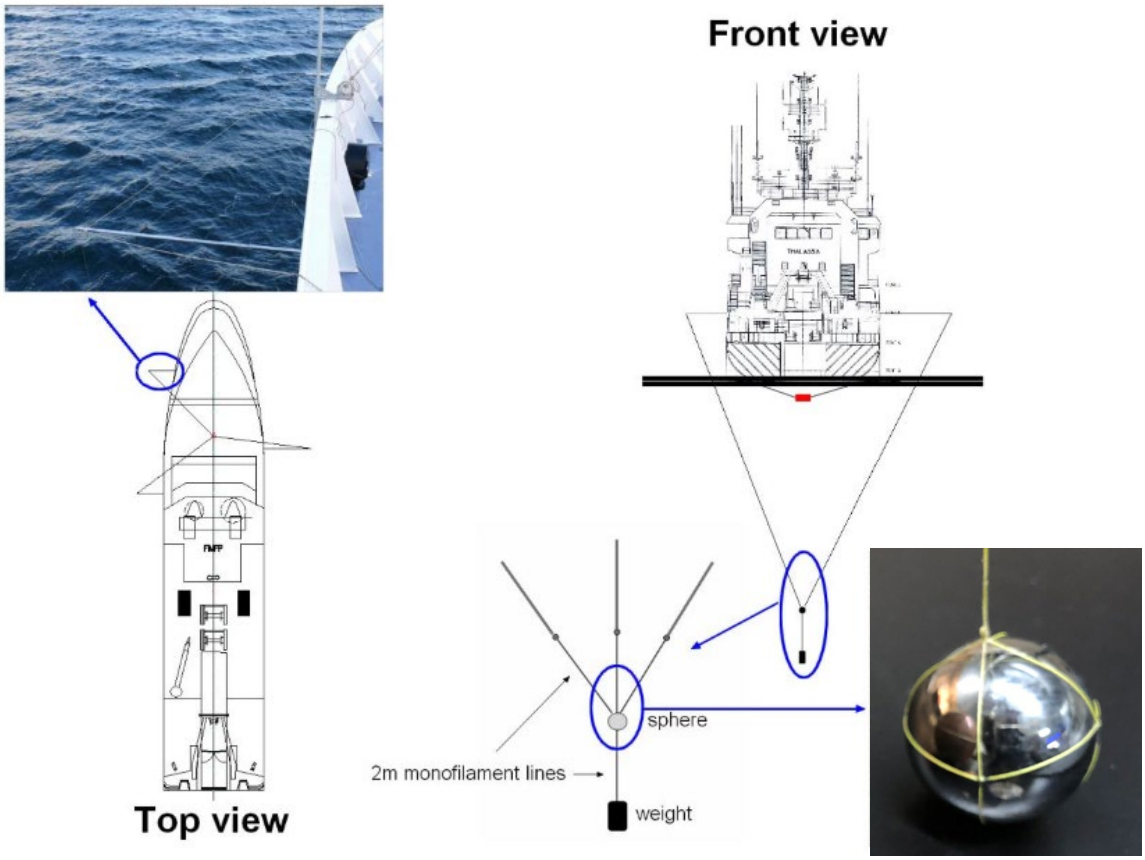


Figure 1. The three-line method for suspending a sphere below a hull-mounted transducer. The monofilament lines should be attached to the mesh bag at different locations to minimize phase noise at high frequencies (i.e. >100 kHz). Note, if the weight is too heavy, the net bag may break and the sphere could be lost. The weight should be suspended 5m below the sphere. Diagrams reproduced from Demer et al. (2015).

Steps for suspending sphere:

1. Calibration sphere should already be fitted with a monofilament mesh with an attaching loop.

2. Set up calibration winches to manoeuvre sphere under transducers. Ensure each monofilament line has a loop tied for securing the sphere.

3. Pass a small rope under the keel by either weighting the rope using shackles and walking the rope under the vessel or using a small boat. Ensure that rope will avoid protrusions on hull of vessel that may snag the rope or calibration lines.

4. Attach rope to the end of the monofilament line, fed through rod or winch. Do this on the side that only has a single rod/winch.

5. Carefully draw the monofilament under the keel to the opposite side of the vessel.

6. Place end monofilament loops from all 3 rods over hand, pass loop on sphere through 3 end loops and pass sphere through its own loop to secure all together.

7. Although you can calibrate using the sphere on the line on its own, you may find it easier to put a weight below. A shackle attached to a ~5 m length of monofilament to the loops in the same way as the sphere. This shackle will act as a weight for the sphere and lines but is far enough below the sphere to not interfere with calibration. Ensure that any knots securing the shackle are away from the sphere. Be sure not to overload the lines or they may snap and the sphere may be lost.

8. Dip sphere plus any monofilament knots near the sphere in 25-50% liquid soap to water ratio to break surface tension on deployment.

9. Pay out monofilament on winches to align the sphere under the transducer.

10. Keep someone monitoring the EK80 screen looking to see whether the target comes on screen (on ‘Active’ EK80 panel view on Sv (20 log) to more easily locate the sphere).

11. Adjust the reel lengths / locations slightly to get the sphere in the main target area on the EK80 calibration screen (see below). Often you will see either weight or sphere in a side lobe, but just not the main target area. Try paying in and out on each line a bit to see if it gets closer (i.e. intensity gets stronger) – small amounts of movement.

12. Be patient. Once you have located the sphere, it is worth marking the monofilament lines at the rod/winches so it is easier to pay out the correct amount of line and locate the sphere next time.

7) Setting up the EK80 software for calibration

1. Turn on the transceivers.
2. Turn on the EK80 display and processor unit.
3. Open EK80 software.
    a See the Simrad EK80 manual for full details of calibrating and running the EK80.
4. Turn pinging on for all frequencies that you will be using during the survey and set to an interval of 1000ms or 500ms.

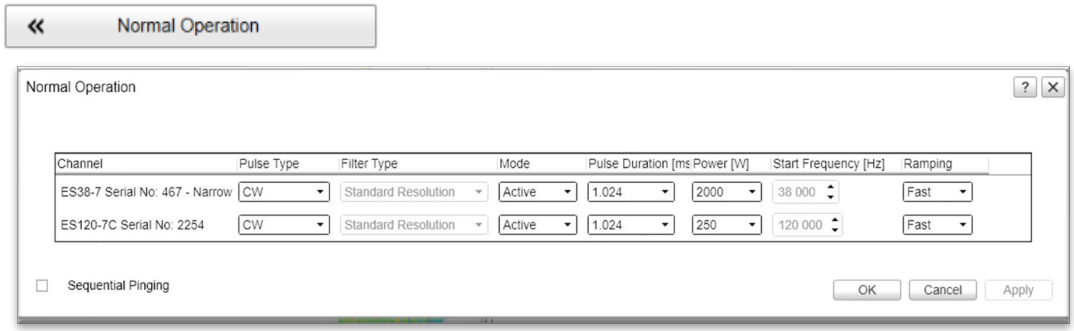
On operation tab 

Ping function	On	
Ping Mode	Interval	
Ping Interval (ms)	1000	i.e. once per second

1. Check the parameters of the transducer ping cycles. It is essential to calibrate at the same power and pulse length settings that will be used during data collection. Following Krafft et al. 2021:

Parameter/Frequency (kHz)	38	120
Transmit power (W)	2000	250
Transmit pulse duration (ms)	1.024	1.024

On operation tab

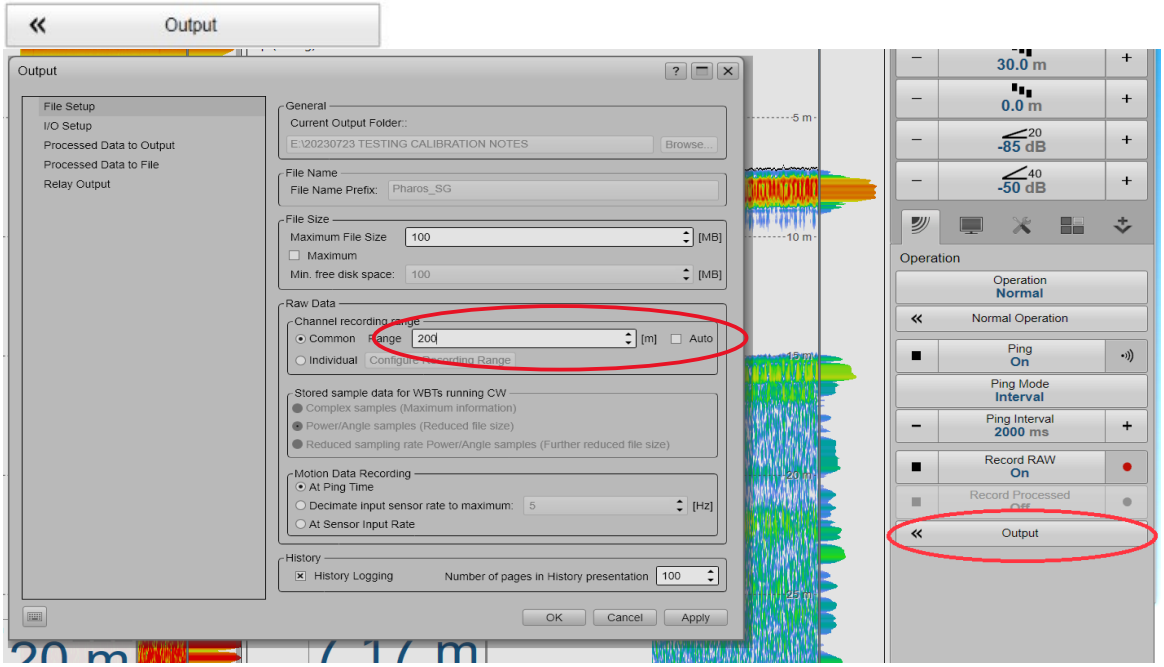


Pulse type: **CW** Mode: **Active** Ramping: **Fast**

2. Set channel recording to Common with a range of 200m (in 50-70m water depth) and make sure Auto is unchecked.

3. Ensure that Individual configuration Auto boxes are also unchecked, this is to prevent the echosounders waiting for a ping to return in empty deep water even if individual is unchecked

On operation tab

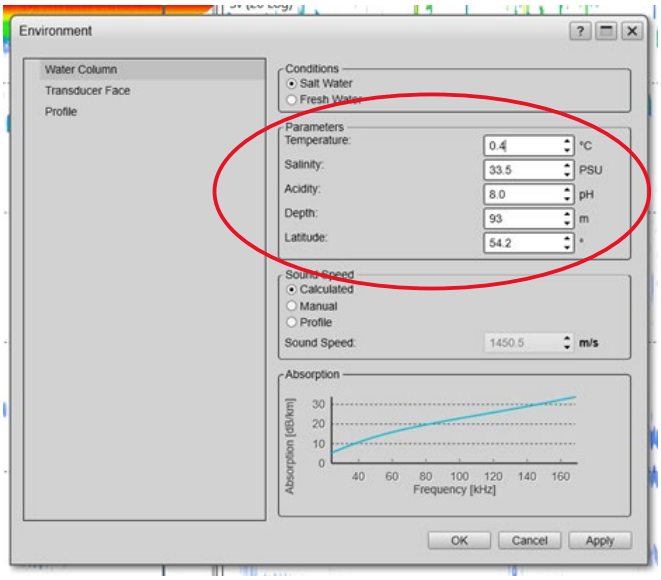


After calibration you must change channel recording Range back to 1100m and ping interval to 2000 ms for data collection

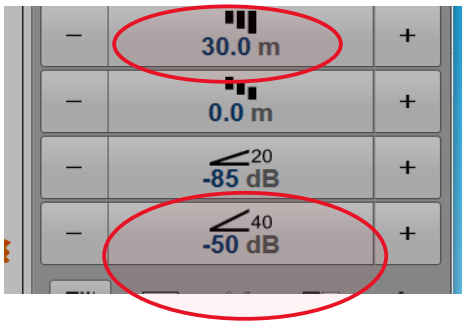
4. Enter the environmental data from the CTD deployment

On setup tab

- Check: Salt water
- Enter the average Temperature and Salinity values to one decimal point, these values are taken from an average of the CTD data between transducer face and depth of sphere
- Acidity: 8.0 pH
- Latitude: this is the vessel's geographical latitude (°)
- Depth: the current depth under the keel (m)

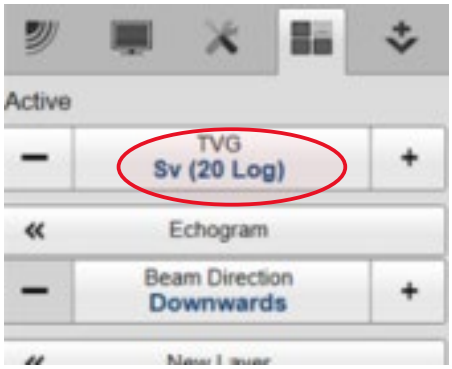


1. Set the range on the main page to be 30 m and ensure the threshold for the 20 angle is -85dB and 40 angle is -50dB.

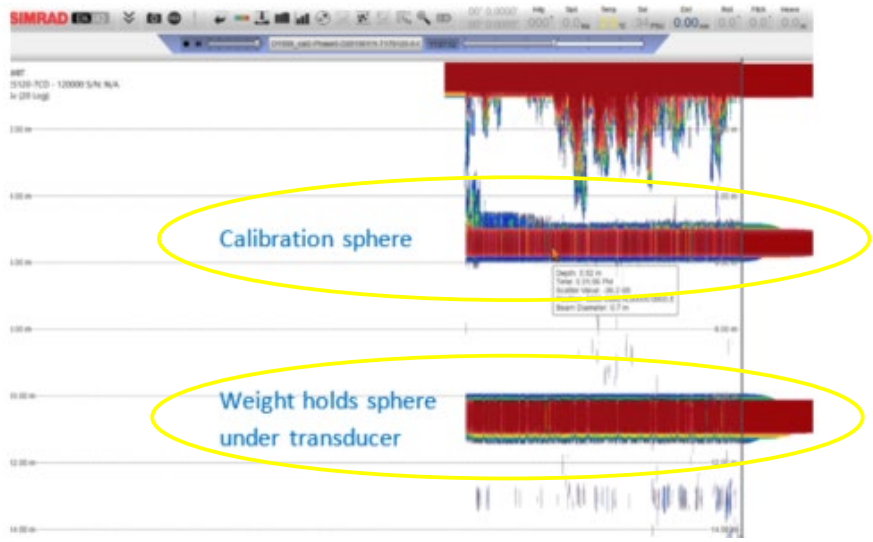


2. Set to Sv (20 log) and check Apply to All box to more easily locate the sphere. This gives a more detailed view.

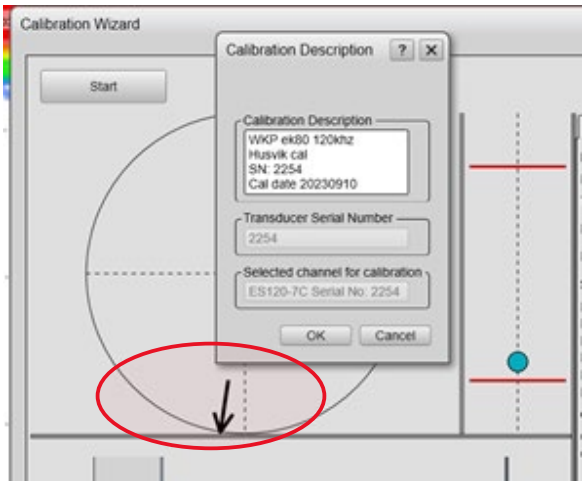
On Active tab 



3. Looking in the window for the transducer you are calibrating, adjust monofilament line (sphere) by hauling in, paying out, in small increments until sphere is underneath the transducer. **The sphere should be 15-20 m from the transducer face.**



If you are struggling to find the sphere, it could be worth starting the calibration wizard window (instructions in the following pages) as there is an arrow pointing in the circle showing which way the sphere is from the echosounder beam.



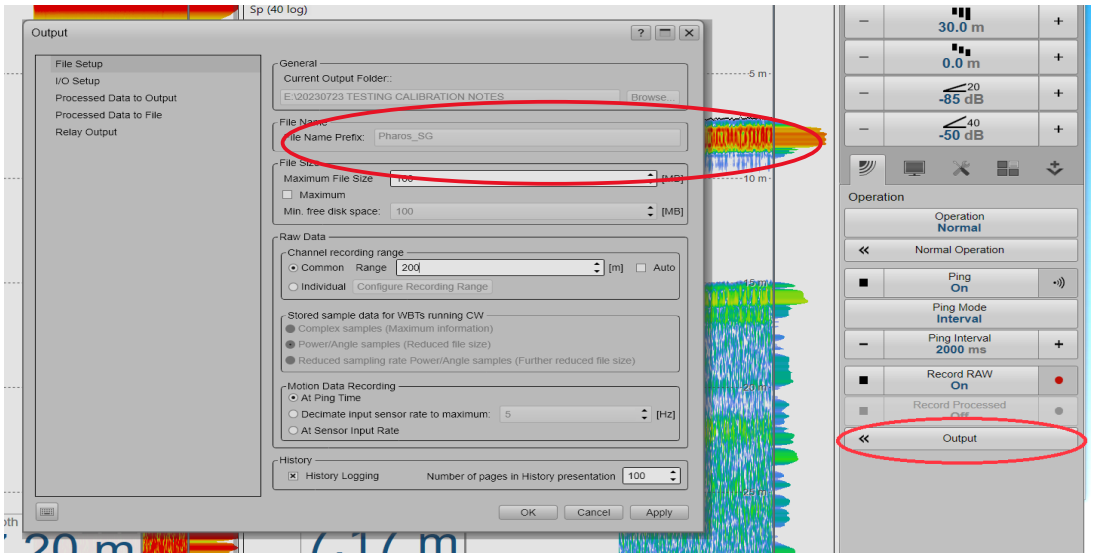
4. Turn recording on and set output folder

On operation tab

Record RAW ON

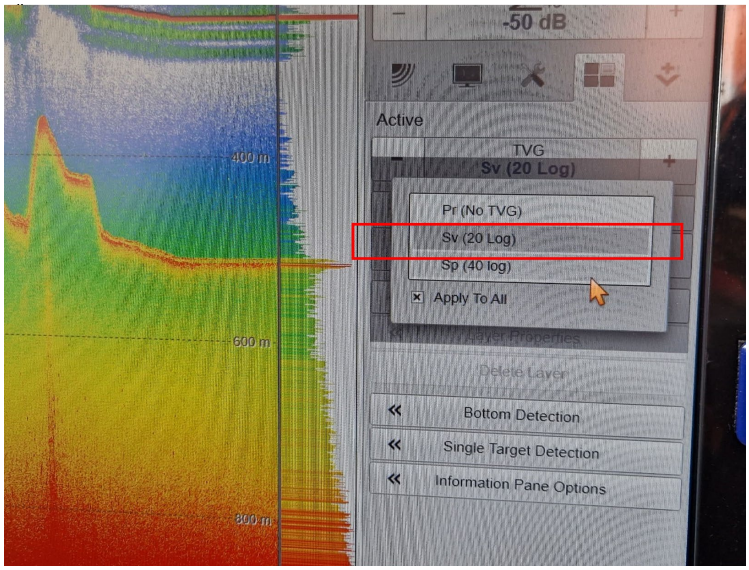
Output

Set current output folder – Browse – New Folder – YYYYMMDD_Calibration



1. For the calibration switch to Sp (40 log) and check Apply to All box. This is less sensitive to noise so helps to identify only single targets and possible encroaching seals etc.

On Active tab



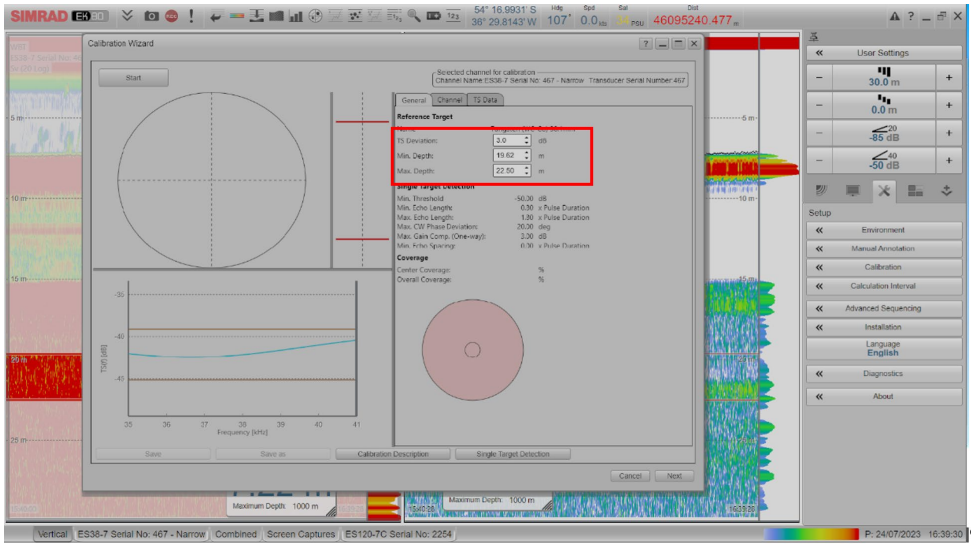
8. Calibration settings

On setup tab

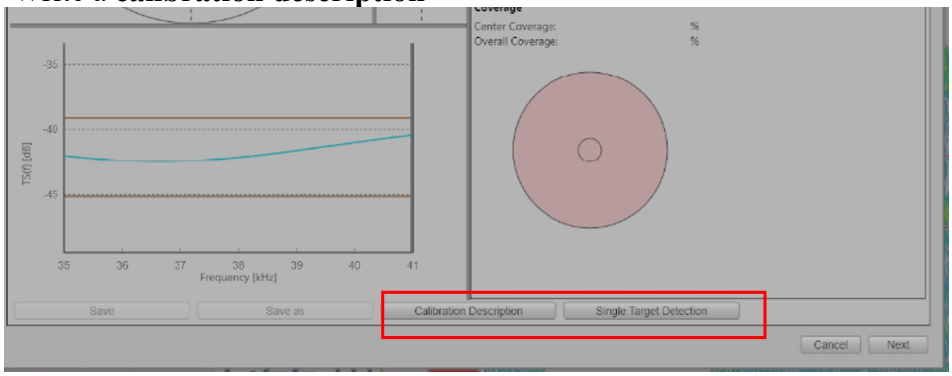
- New calibration from raw data (Real time or Replay) > Next
- ***Channel*** select which Transducer you are calibrating (either 120kHz or 38Khz)> Next
- Select the ***Sphere*** type and size (eg Tungsten 38.1mm) > Next

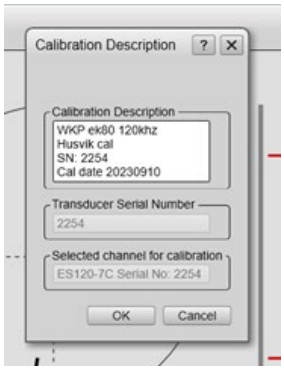
In the calibration wizard, move the **red 'depth' lines** to either side of the calibration sphere (+/- 2.5m). This can be done by either clicking and dragging them on echogram view or by adjusting Min. Depth and Max. Depth values on calibration wizard. The calibration sphere will appear between min and max depth lines with other data greyed out.

- Set the **TS deviation** to 3dB. This will reject any 'hits' that are far from the theoretical TS of the sphere and so may take longer to calibrate but should result in only good data being accepted as the sphere.



Write a **calibration description**

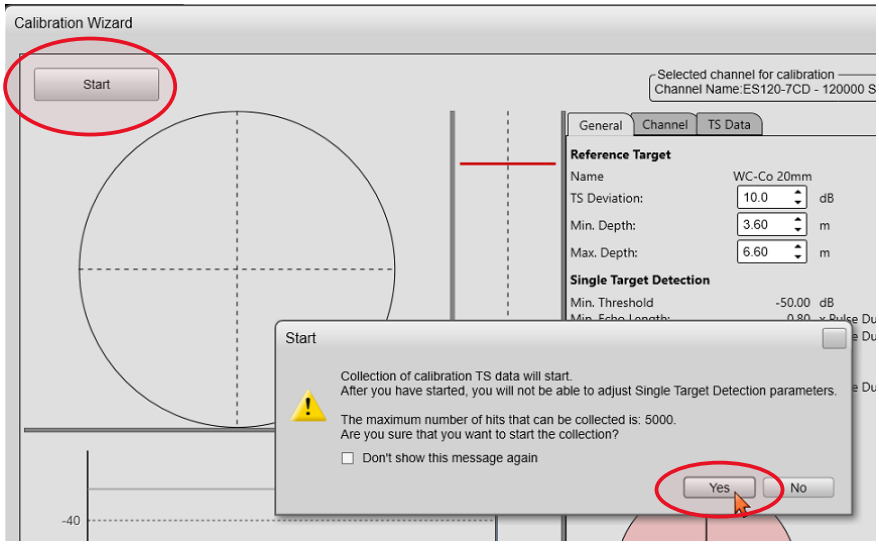




Vessel IMO:
Calibration location: Lat Lon (Decimal degrees)
Calibration Date: YYYMMDD

Leave the **single target detection** parameters are as default.

Press **Start** > **Yes** to start calibration

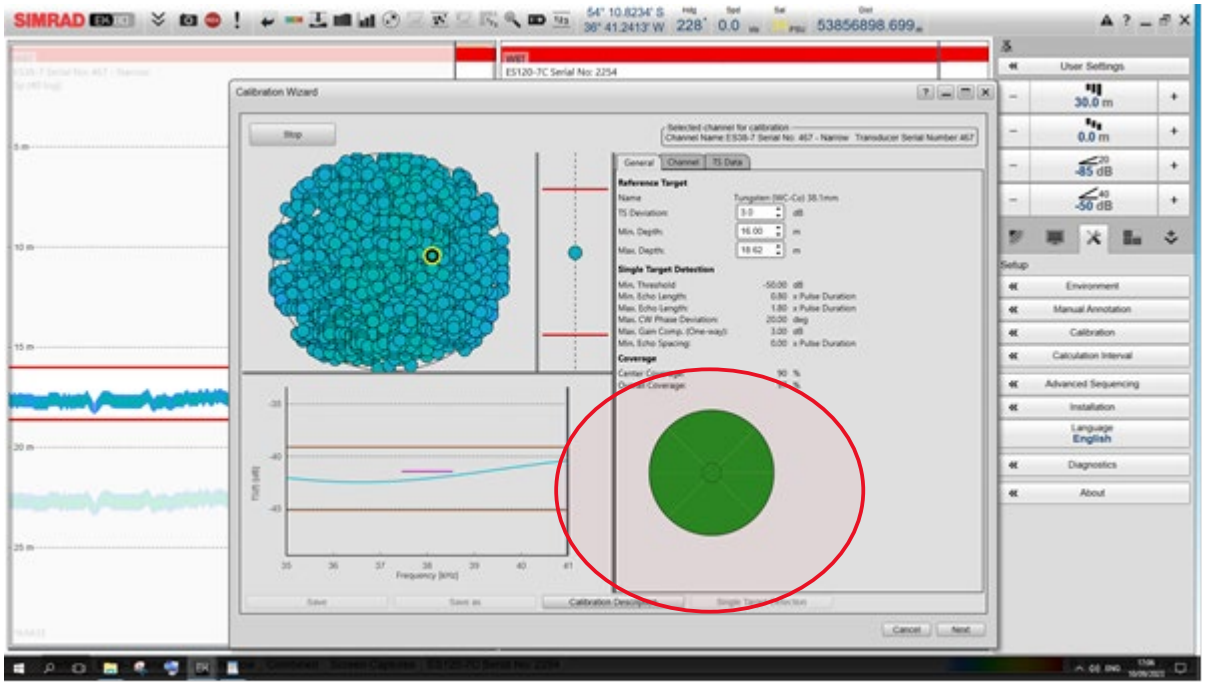


9) Calibration Procedure

1 Adjust line (sphere) as needs be to get sufficient coverage in all quadrants. Hits will appear as dots (colour varies slightly due to the dB of the target) in the target area. The sphere should be moved gradually, remember that currents and vessel movements will affect the sphere position.

2. If a seal or fish get in the way you can STOP the calibration and START again when the sphere is in the clear. The sphere needs to be the only thing in the calibration region between the lines.

3. When **all quadrants and centre circle are green** (or coverage is at **80%** in centre and overall) the calibration can be stopped. However, it is worth collecting more hits as if some need to be suspended later then there should still be enough for a good calibration in post processing. Note that the calibration will stop once a threshold of 5000 pings has been reached.

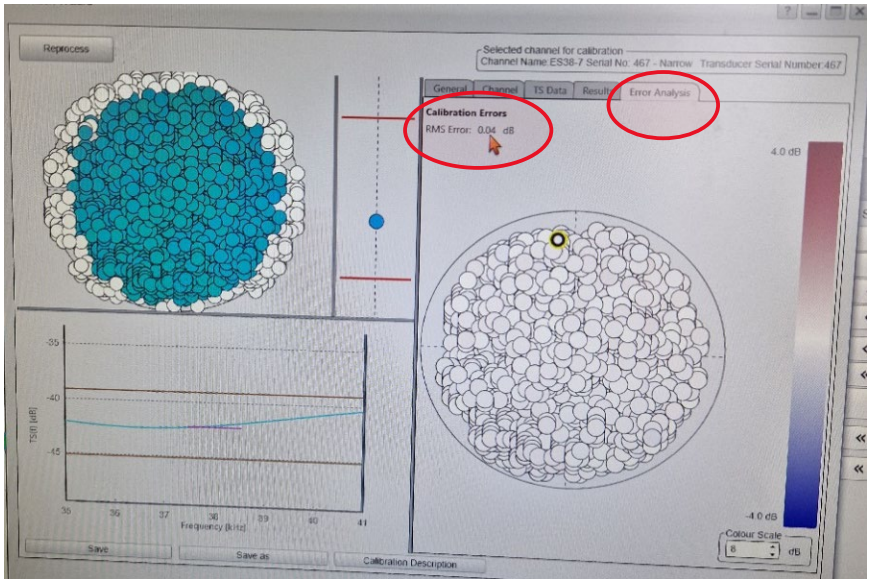


In calibration window press **STOP > Next > Yes** (save and proceed to next step).

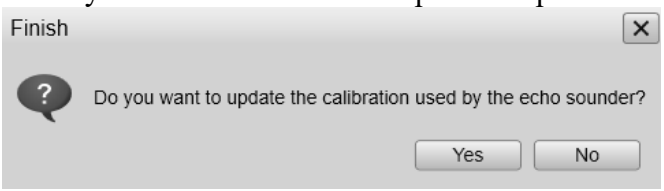
Save As > Save as .xml files in an appropriate place. This will be submitted to CCAMLR with survey data

4. Check the *Error Analysis* tab. An **RMS error < 0.2 is ideal**. When the RMS value is in between 0.2 and 0.4 dB, this indicates conditions is not perfect but still acceptable. When the RMS value is higher than 0.4 dB the calibration is poor, and should preferably be rejected and not used for updating of the transducer parameters (Kongsberg Maritime AS, 2012).

5. Acceptable beam widths are ±10% or your transducers nominal beamwidth e.g. **6.3°-7.7°** for a 7° beam angle.



Finish >
If results are poor or you get a warning, click NO to 'Do you want to update the calibration used by the echosounder' and repeat or reprocess the calibration.



The software should alert you if the calibration is poor.

If the results are **good** click **YES** to 'Do you want to update the calibration used by the echosounder'.

1. **If YES > BE PATIENT**

   Give the system time to upload and apply the new calibration. The calibration wizard will close.

   Once uploaded the echosounder will switch off. Go back to operation page and turn back to 'Normal'.

2. Check that all settings are correct and have not reverted to default values.

3. Repeat entire calibration process on the other transducer.

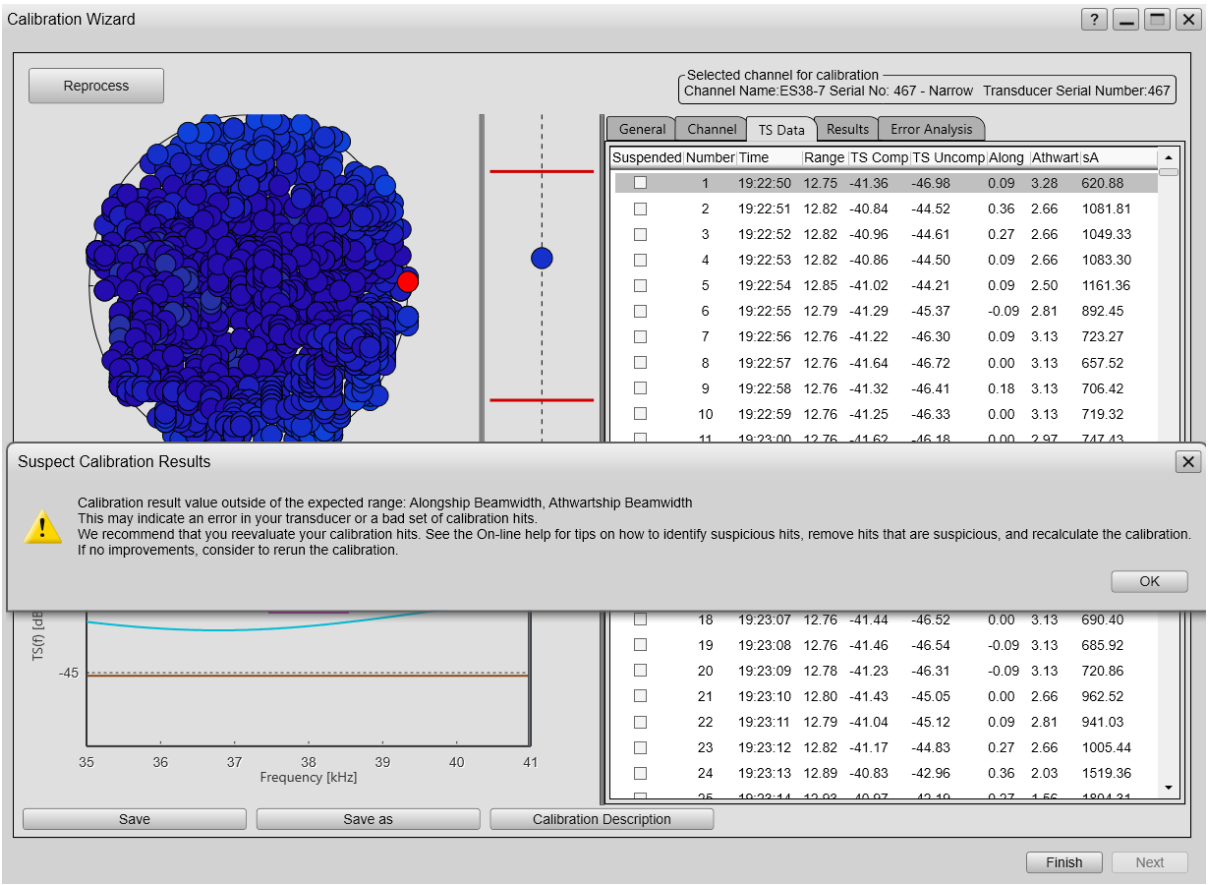
ONCE BOTH CALIBRATIONS ARE COMPLETE CHANGE SETTINGS BACK TO DATA COLLECTION SETTINGS

Output > Channel Recording Range (m) > Common 1100m

Ping Interval > 2000ms

Active Screens to Sv (20log) > check Apply to All

10) Reprocessing a calibrations



If you receive a suspect calibration warning it may be possible to reprocess using the collected .raw calibration files but suspending bad data pings.

1. To suspend hits

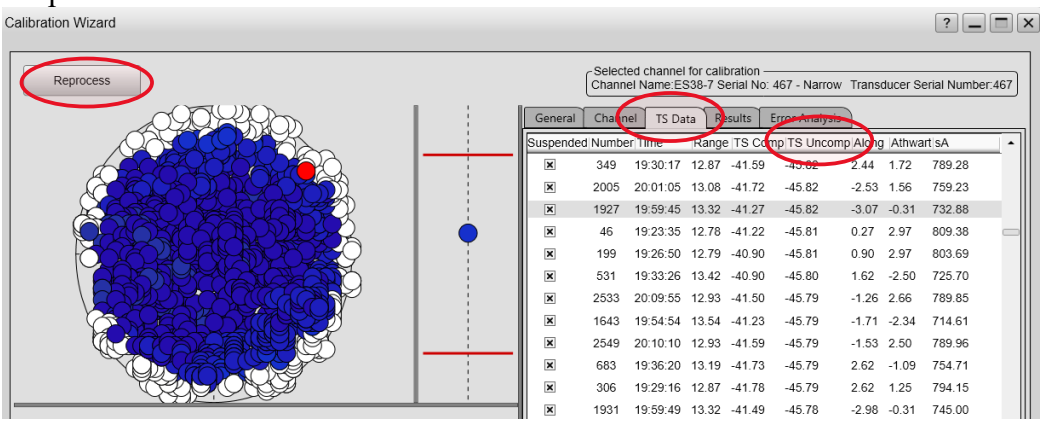
    - On the *TS Data tab* > order the *TS Uncomp* values by clicking *TS Uncomp* header.

2. Suspend hits (by clicking and putting a cross in the Suspended box) with a TS furthest from the expected value of the sphere. Normally it is the lowest TS values that need to be suspended.

    - Suspended hits will appear white in the display.

    - You can suspend lots of hits at once by click a value, holding shift and clicking on the last hit you want to suspend. Then click any highlighted box and all will check with a cross.

3. 'Reprocess' the data.

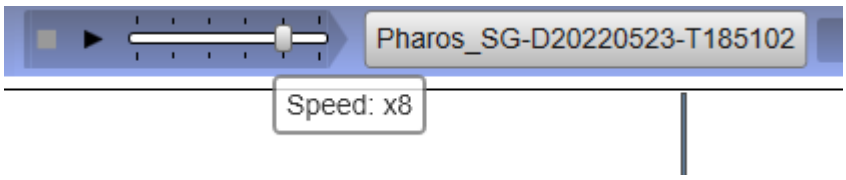


4. This process can be done iteratively, by gradually suspending *TS Uncomp* values and reprocessing until an acceptable calibration is achieved.

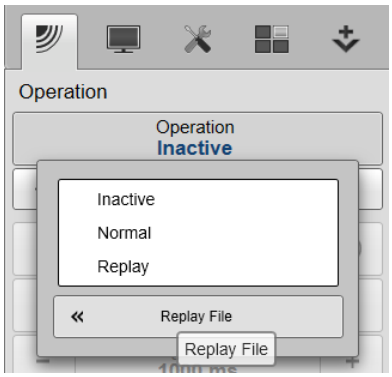
5. Once the reprocessed results are within bounds, you can finish and accept.

Reprocessing calibration RAW data

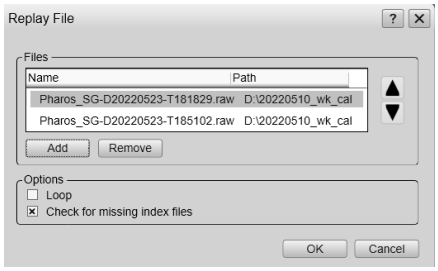
If you receive an error in your calibration it may be possible to reprocess using the collected .raw calibration files but suspending bad data pings. These can be done on time stamps e.g., if an animal gets in the way of the sphere (check by replaying and identifying suspect regions in the file) and/or by suspending pings based on unusually high or low uncompensated TS values. Speed of replay can be controlled using the slider next to the play button.



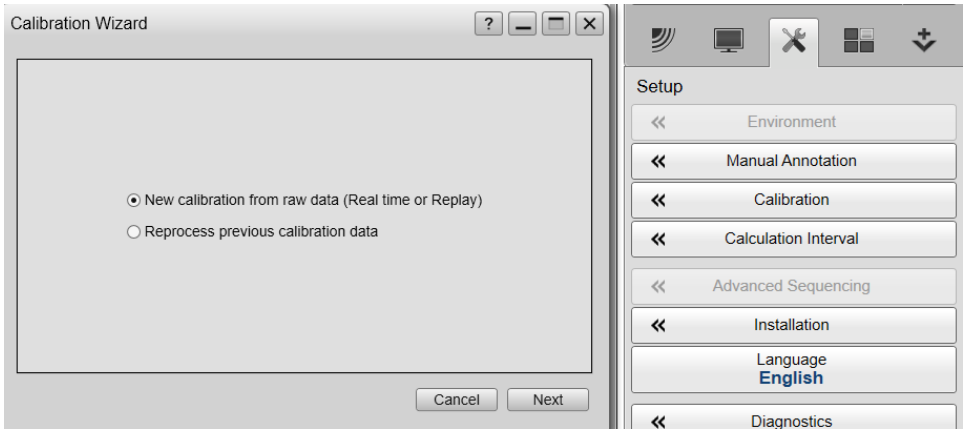
Operation tab > **Operation** > **Replay File**



Add > Browse to .raw files from calibration **Open** > **OK**



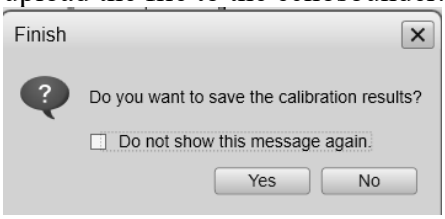
Setup tab > **Calibration** > **New calibration** from raw or replay > **Next** > Select channel (e.g. ES38-7) > **Next** > Select Sphere

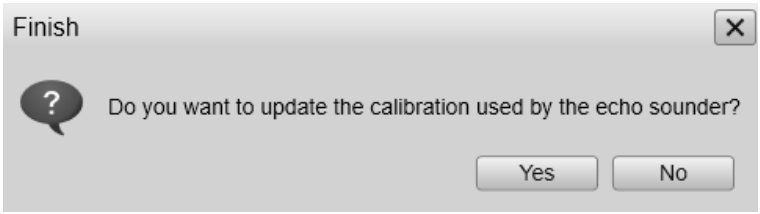


Set TS deviation to 3 dB > START calibration and press Play in main EK80 window.

Check the Results and error analysis to check this is in bounds or identify any issues which have resulted in warnings.

Finish > **Yes** to Save the file > **Yes** to Update the calibration used by the echosounder and upload the file to the echosounder.





If in doubt, **DO NOT** update the calibration but seek assistance from Simrad (they will need a copy of the .raw and .xml files).

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References

Demer et al. 2015. Calibration of acoustic instruments. *ICES Cooperative Research Report*. 326, 136 pp., doi: https://doi.org/10.17895/ices.pub.5494.

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Renfree J.A., L.N. Andersen, G. Macaulay, T.S. Sessions and D.A. Demer. 2020. Effects of sphere suspension on echosounder calibrations. *ICES J. Mar. Sci.*, 77(7-8): 2945–2953, doi: https://doi.org/10.1093/icesjms/fsaa171.