# Radar Investigation -16th Century Ship Mast

"Ground-Breaking Technology"

- Innovative use of TreeRadar (GPR) on huge mast.
- We wrapped it in Clingfilm!

**Swedish Vasa Oak Warship**

**The world's largest!**

**Nearly 400 years old!**

## PBA - First in the world:

PBA Consulting is the first consultancy in the world to use TreeRadar GPR to investigate the internal condition of timber ship masts - this one was over 35 metres high! The investigation was in association with TreeRadar Inc. USA.

## The only Totally Non-Invasive system?

TreeRadar was used for this challenging task, being the only totally non-invasive investigation procedure for standing timber/trees- no pins; no drilling. TreeRadar also gives a high degree of accuracy in predicting sound timber measurements – important in assessing the integrity of the mast (as well as trees) to ensure public safety.

## PBA wrapped it up in Clingfilm

The delicate surface of the mast had to be protected for the duration of the survey. PBA Consulting wrapped over 30 metres of this ancient mast in a protective layer of cling film. We worked from specially erected scaffolding.

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## Museum environment - low timber moisture values - bounced radar signals off metal plate


Being in the purpose-built Museum since the ship "left the seabed" in *1961,* the mast moisture values were much lower than living trees and open stored timber. Therefore, the dielectric values of dry wood are close to that of air, the reflections back from the opposite (far) surface of the mast were weak. So a metal reflector plate was used to reflect back the signals to the GPR antenna. This enabled real-time speed analysis of the signal; internal refractives were enhanced. This assisted in the defining of the precise depth of timber for analysis.

## 900 MHz antenna used - metal reflector plate held 180° to antennae during scanning process

Thirty cross sections were scanned over selected areas approximately 50 centimetres apart. At each location, a detail visual record of the external condition of the mast was made, entered into the database and plotted to the massive pole on masking tape. The information included cardinal points compass, significant cracks and other features. The plotted data was electronically tagged during the scanning process to assist the analysis process. These tags are shown as green dotted lines on the cross-sectional visuals and were an aid to analysis and in correlating information back to the mast.

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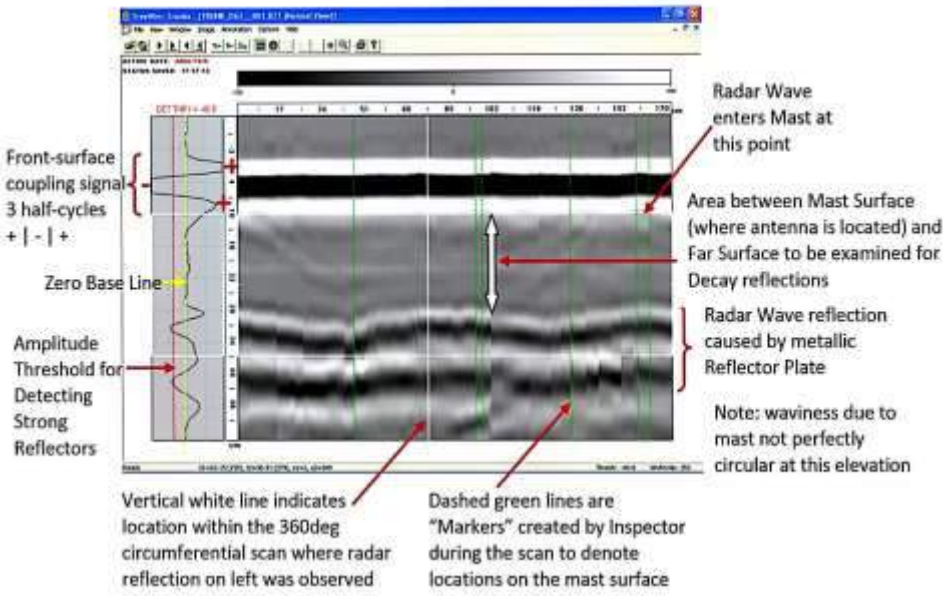
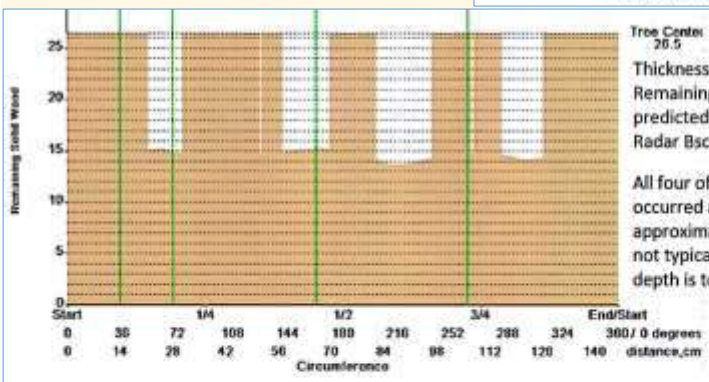
## Analysis carried out by the renowned TreeRadar expert Tony Mucciardi: TreeRadar Inc. America

### Data Analysis

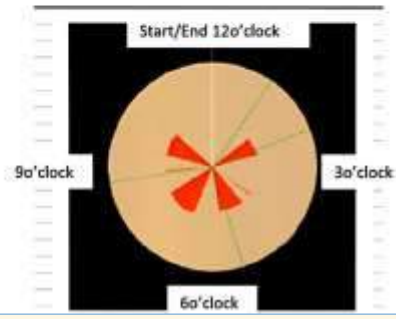
The detailed analysis was carried out by Tony Mucciardi using TreeWin software. Targeted searches were performed to identify locations where the signal exceeds predetermined thresholds.




Thickness Map showing the Remaining Solid wood as predicted by analysis of the Radar Bscan.

All four of the reflections occurred at the same depth of approximately 15cm which is not typical of decay since the depth is too constant.




2D "Virtual Saw Cut" Cross-Sectional Map showing the targets detected at this elevation and their depth. Remaining solid wood can be read from the above Thickness Map.

### Results

Several locations were identified where the signal reflections breached thresholds. These were consistently occurring at around 15cm depth. There were also some smaller benign reflections

The constancy and regularity of depth indicate that these reflections are not associated with biological activity (decay), past or present. Biological activity produces more irregular reflective patterns.

The regularity of signal "echoes" indicates some form of structural change within the mast, doubtless associated with sapwood/heartwood interface and separation of annular ring formation. There may have been some moisture within the interface.