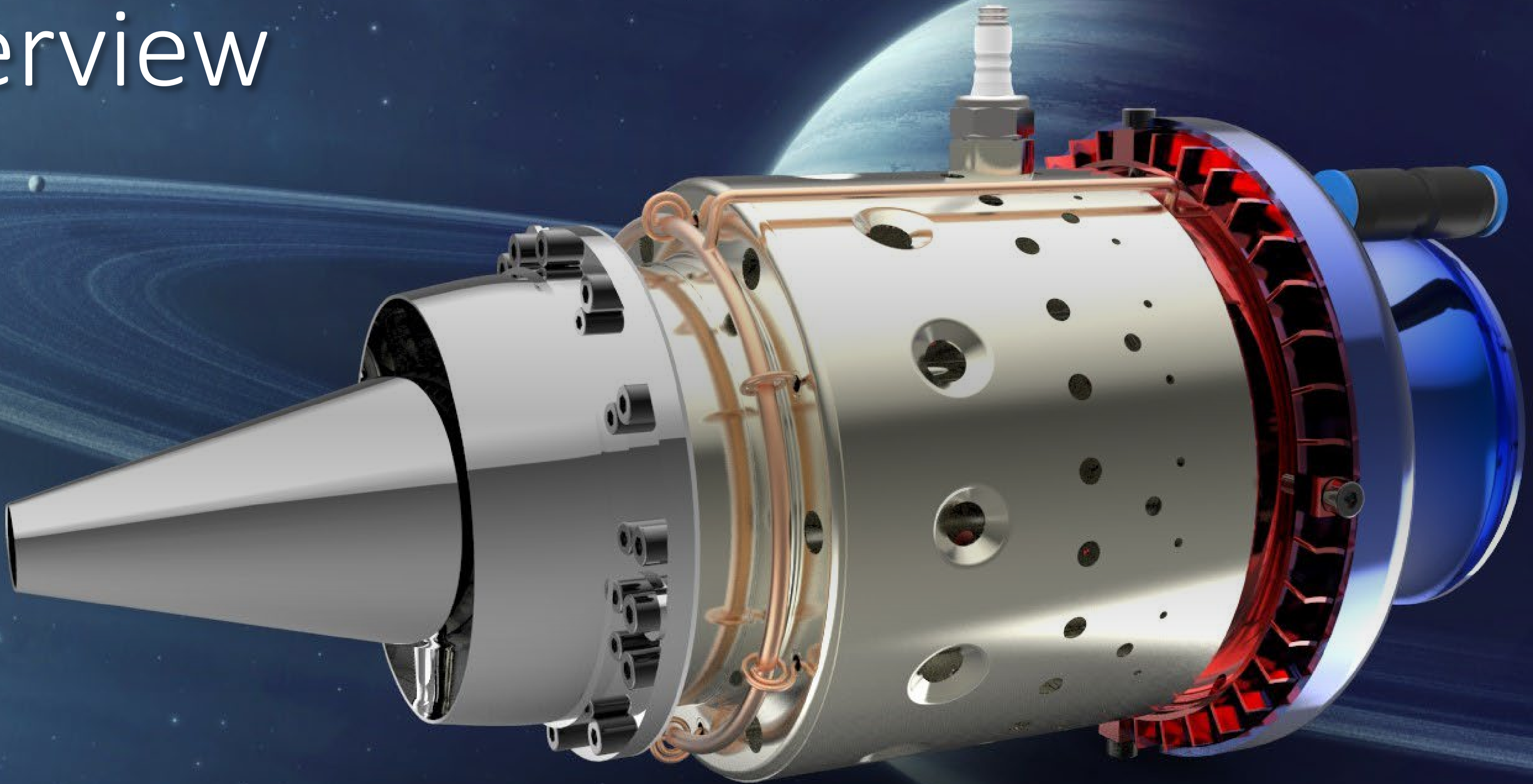
TURBOSCAN

Overview

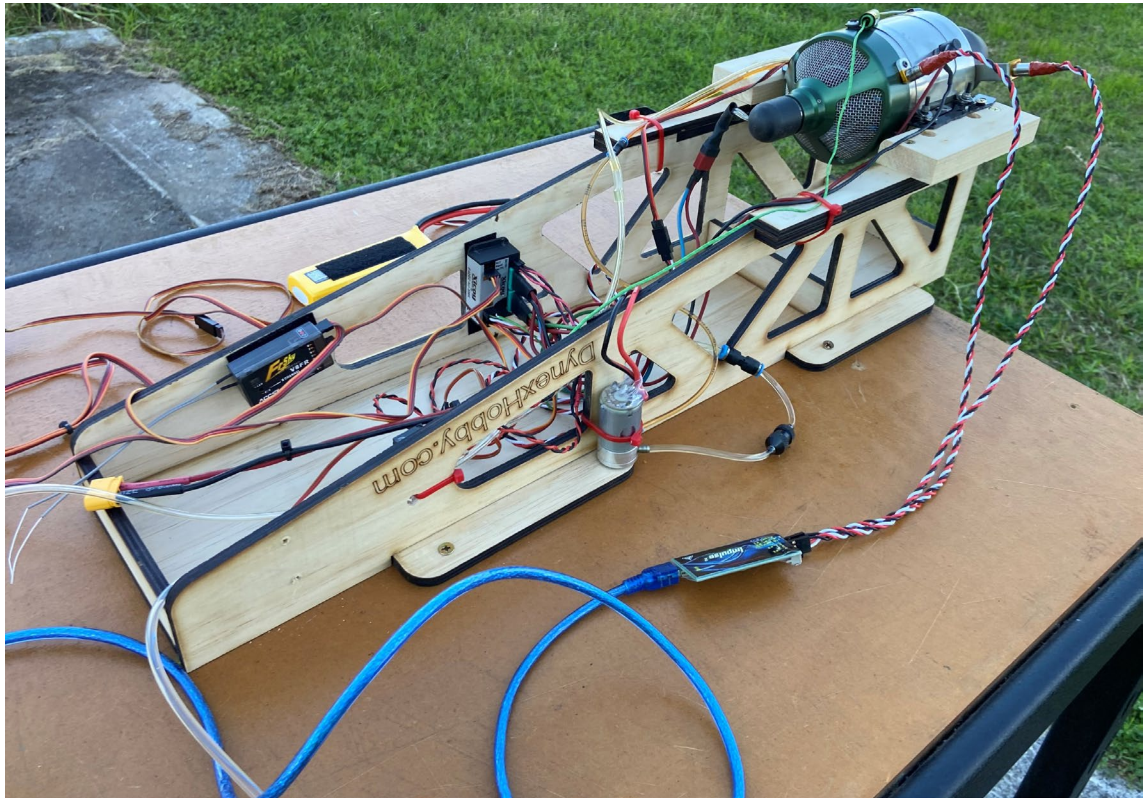


Quick Guide V2

DynexHobby
Delivering good vibrations

What is TurboScan

- TurboScan is a system used to monitor the condition of micro gas turbine engines
  - Turbines are high performance engines and require care to run and service
  - Most failures occur due to some form of wear and tear typically the bearings
  - Unfortunately, except for ECU data, there are not many tools available to monitor these engines.
- TurboScan is a health monitoring system. **It will <u>not predict</u> when failure will occur for engine components!**

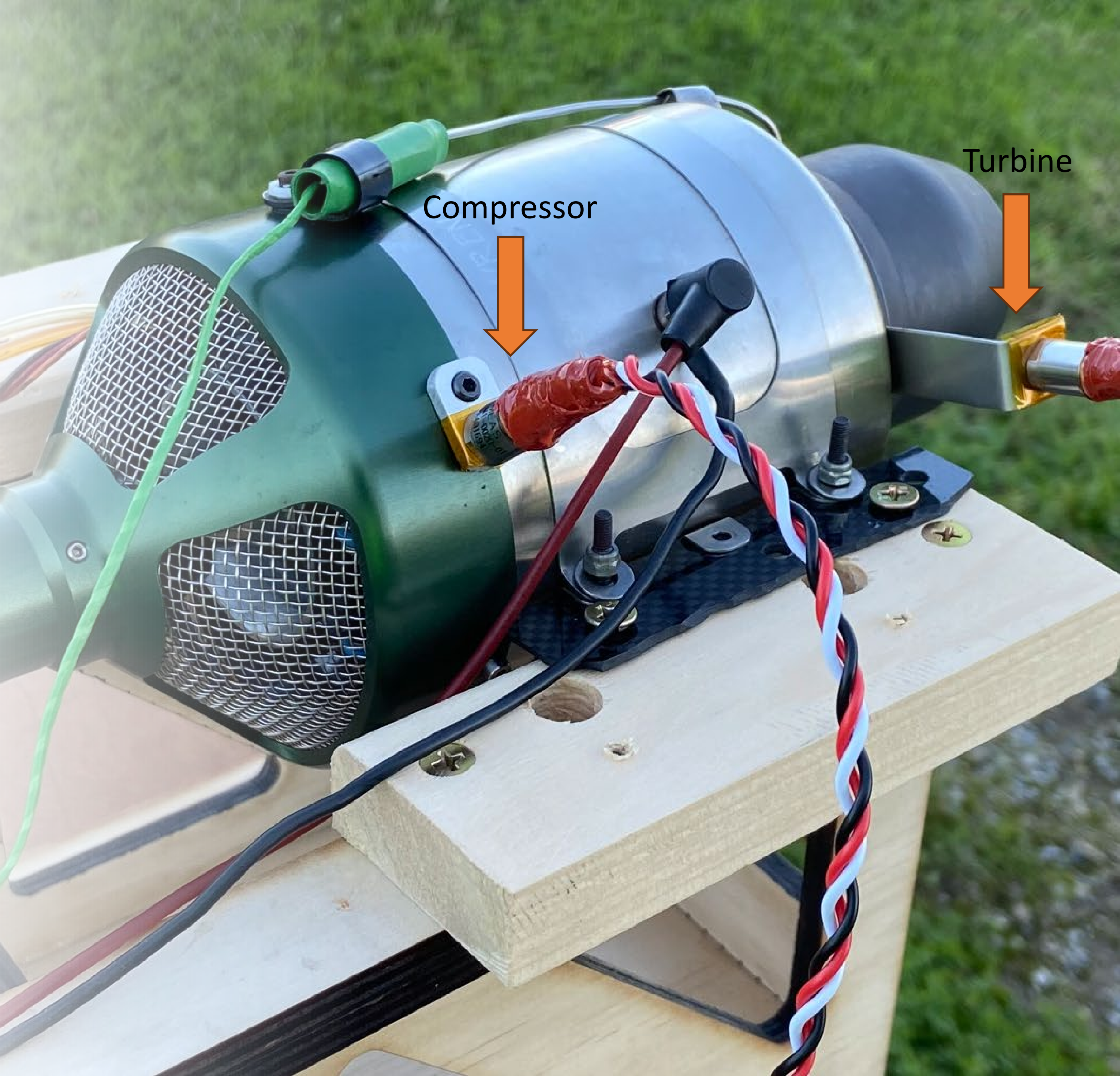


What is TurboScan

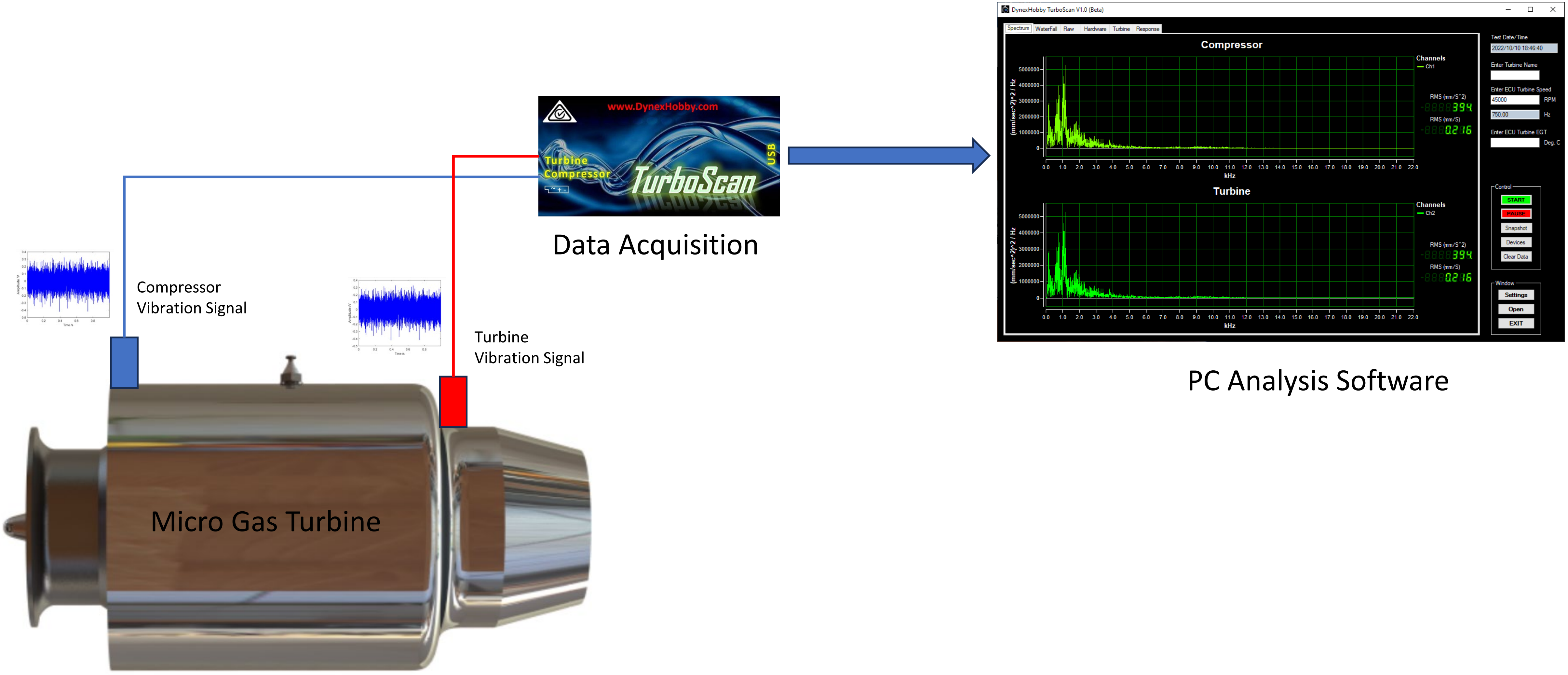
- TurboScan is made up of the following hardware
  - TurboScan unit
  - USB Cable
  - 2 x Accelerometer Sensors
  - Mounting Brackets
- It is also supported by companion software.

Installation

- TurboScan accelerometers are mounted at 2 locations see image on right;
  - Compressor bearing housing
  - Turbine bearing housing
- Brackets pick up on existing fasteners on engine housing. **Warning! Do not modify your engine as this will void warranty and lead to personal injury.**
- Ensure turbine bracket is pointing towards axis of main shaft.
- Now screw the accelerometers onto the brackets.
- Ensure cables are secured away from heat sources and moving parts.
- Connect sensor cables to TurboScan ports.
- **Once testing is done, sensors and brackets <u>should be removed</u>, and engine returned to original configuration for operation in the field.**



How it works

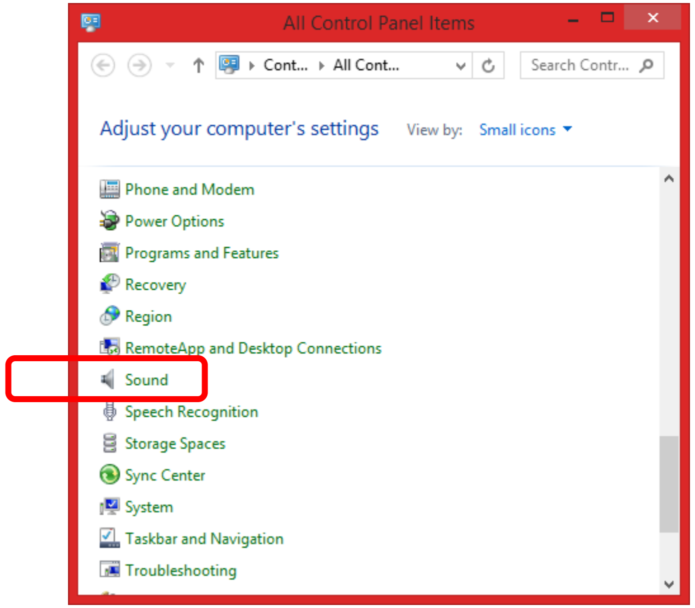

www.DynexHobby.com
Turbine
Compressor
TurboScan
USB
Data Acquisition
Compressor Vibration Signal
Turbine Vibration Signal
Micro Gas Turbine
DynexHobby TurboScan V1.0 (Beta)
Compressor
Turbine
kHz
PC Analysis Software

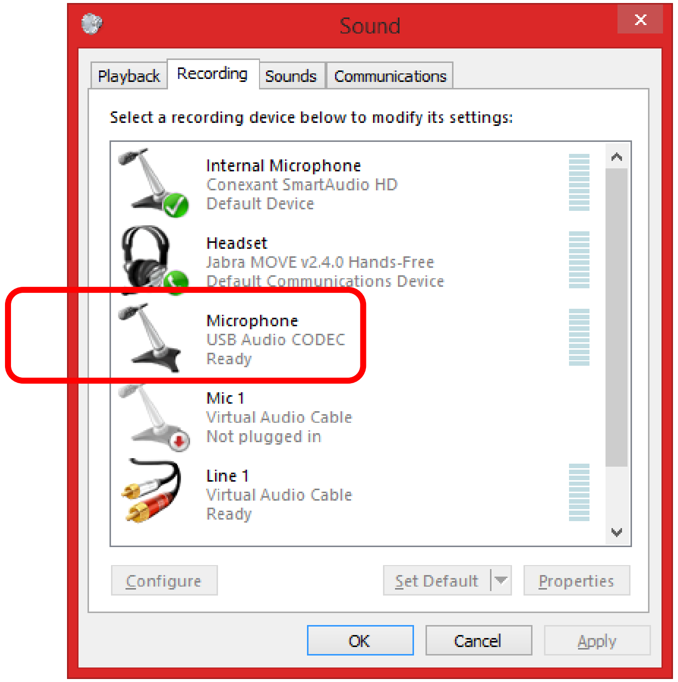
Software

- TurboScan software is unique to TurboScan.
- It only runs on Windows PC.
- It has multiple tabs with various functions. This is covered in next slides.

Software

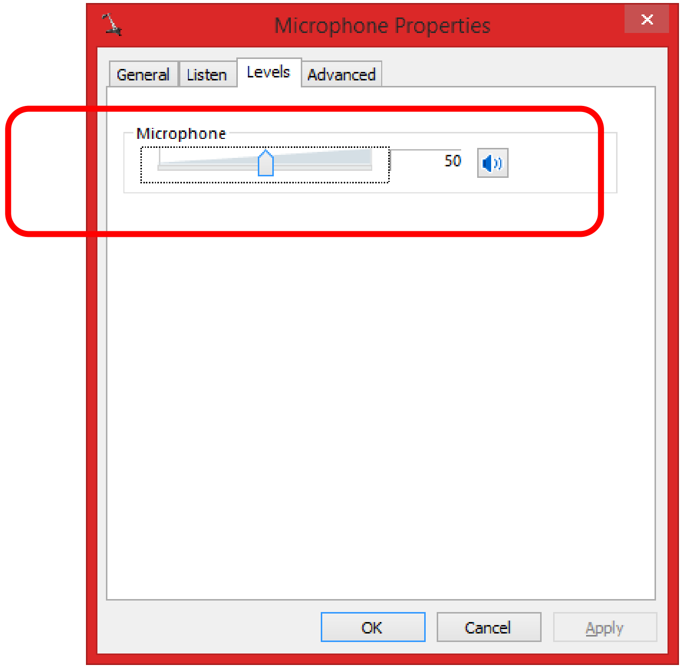
- The TurboScan requires configuration in Windows. The following method illustrates the preferred setup method.
- Open the Sound settings in Windows Control Panel.
- Click on the “Recording” tab and double click on the recording device that TurboScan is connected to,
  - Microphone USB Audio Codec.

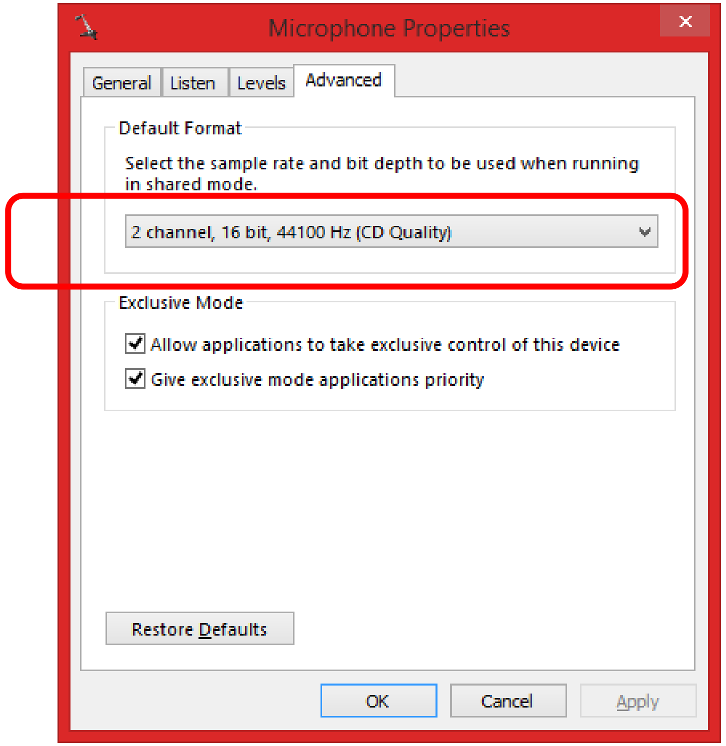




Software

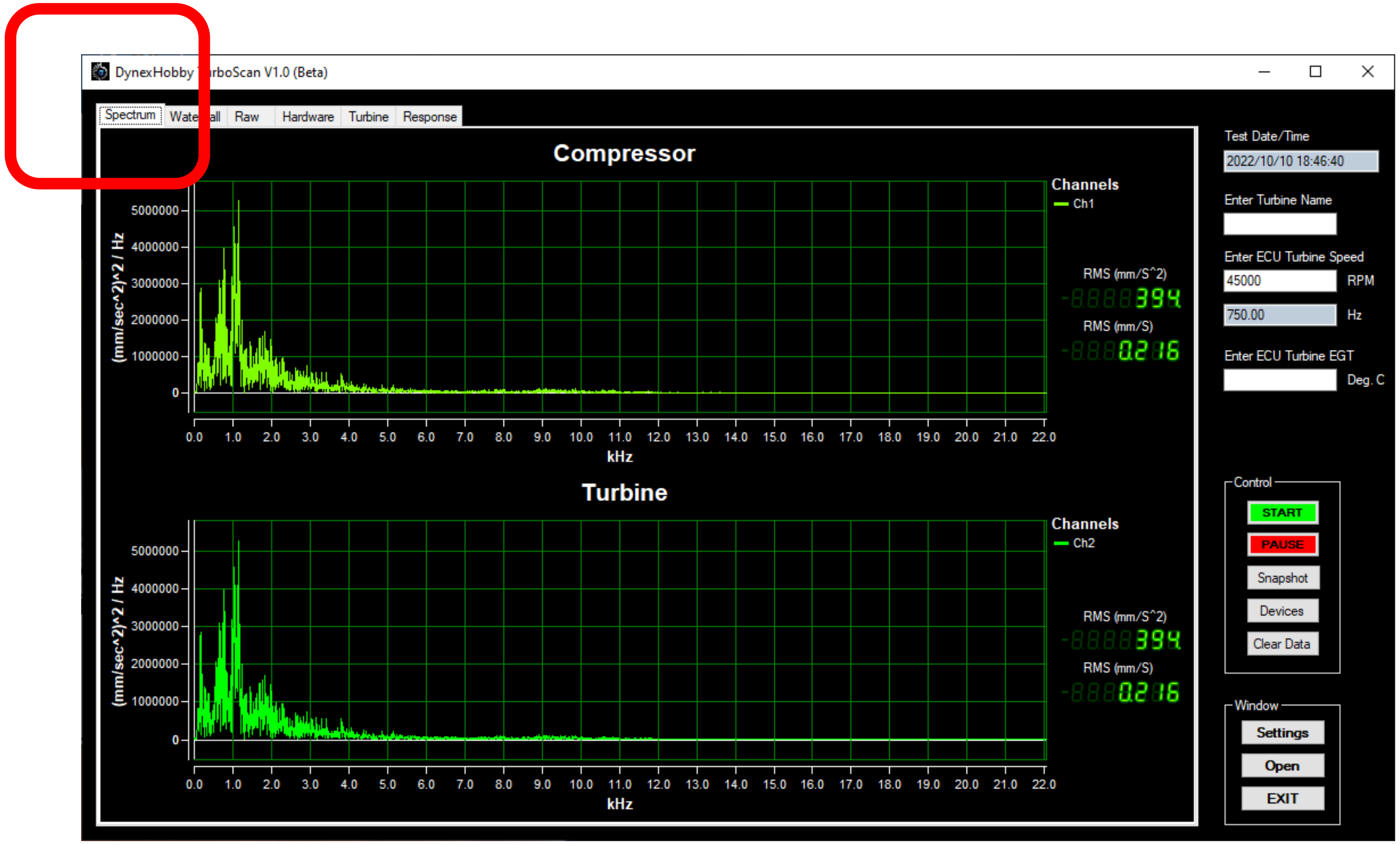
- Click on “Levels” tab. Ensure the volume is not muted. Set at 50.
- Click on “Advanced”. Ensure that the default format has “2 channel, 16 bit, 44100Hz” selected.
- Click “Apply” and “OK”





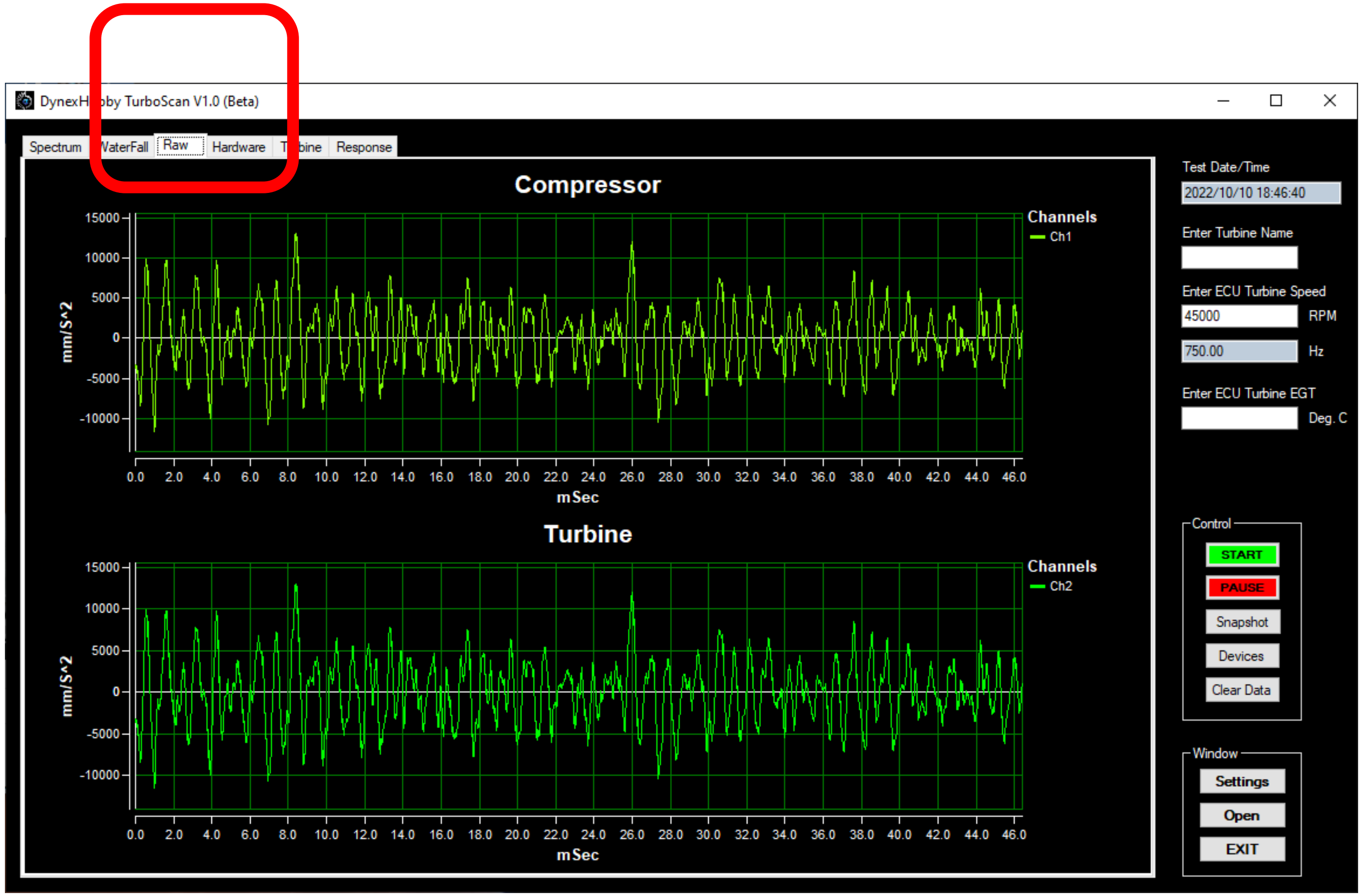
Software

- Spectrum tab measures vibration levels at Compressor and Turbine ends.
- Vertical Axis = Power Spectral Density (accel^2)/Hz
  - This is a measure of vibration energy from the gas turbine.
- Horizontal axis = Frequency (kHz)
- On the right (RMS = Root Mean Square)
  - RMS Acceleration (mm/S^2) is good for measuring high frequency vibrations.
  - RMS Velocity (mm/S) is good for measuring low frequency vibrations.



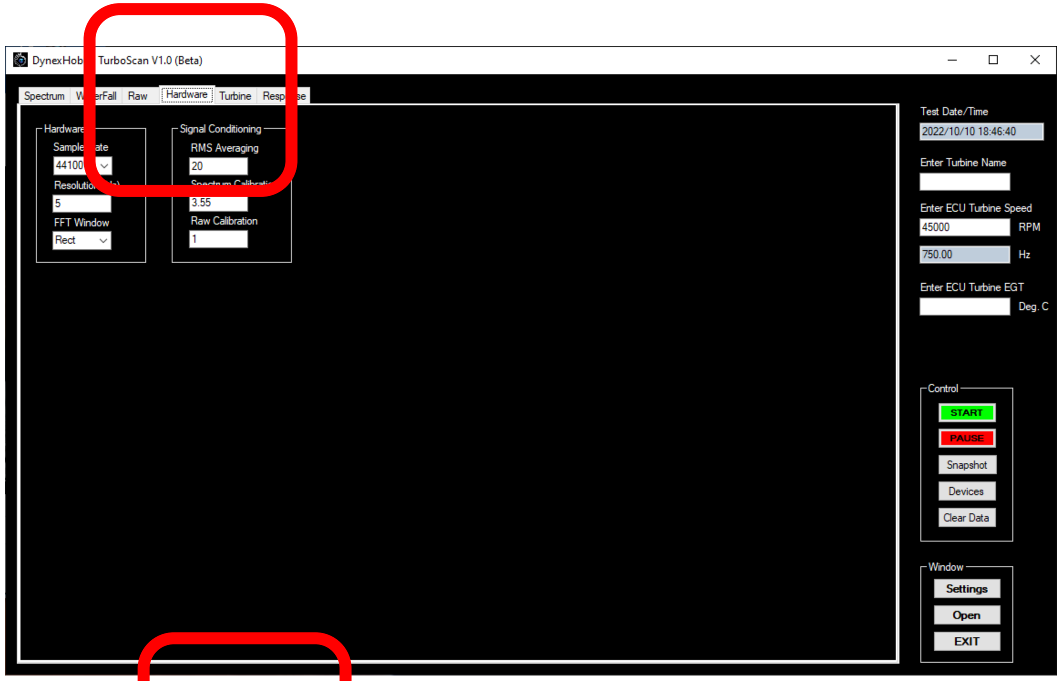
Software

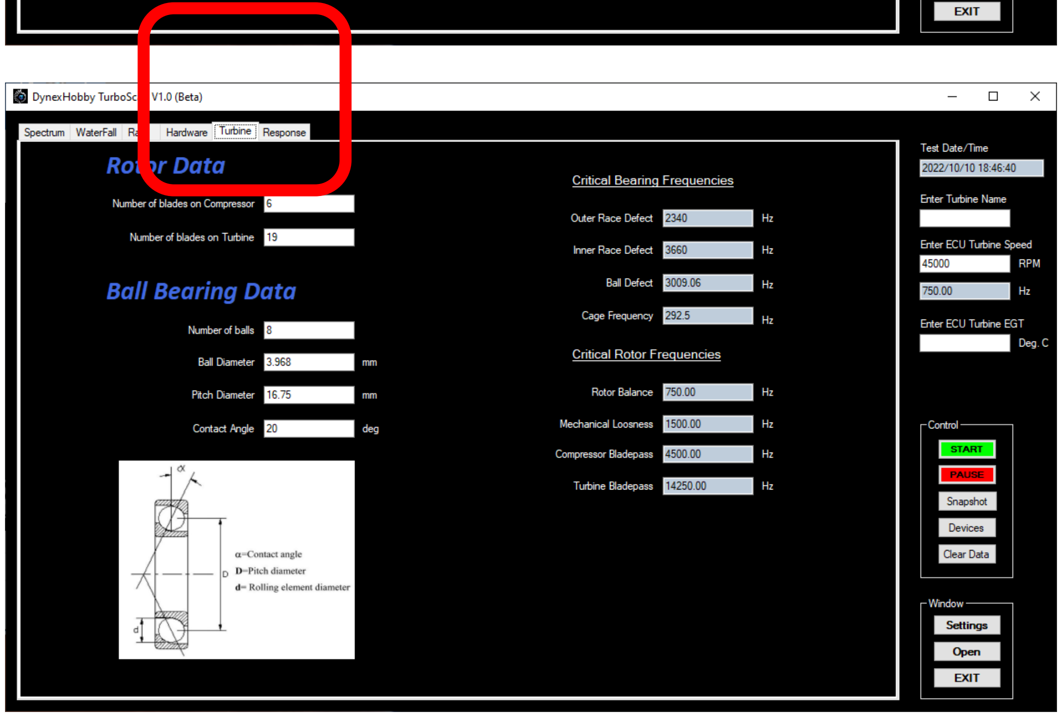
- Raw vibration signal for compressor and turbine stages.



Software

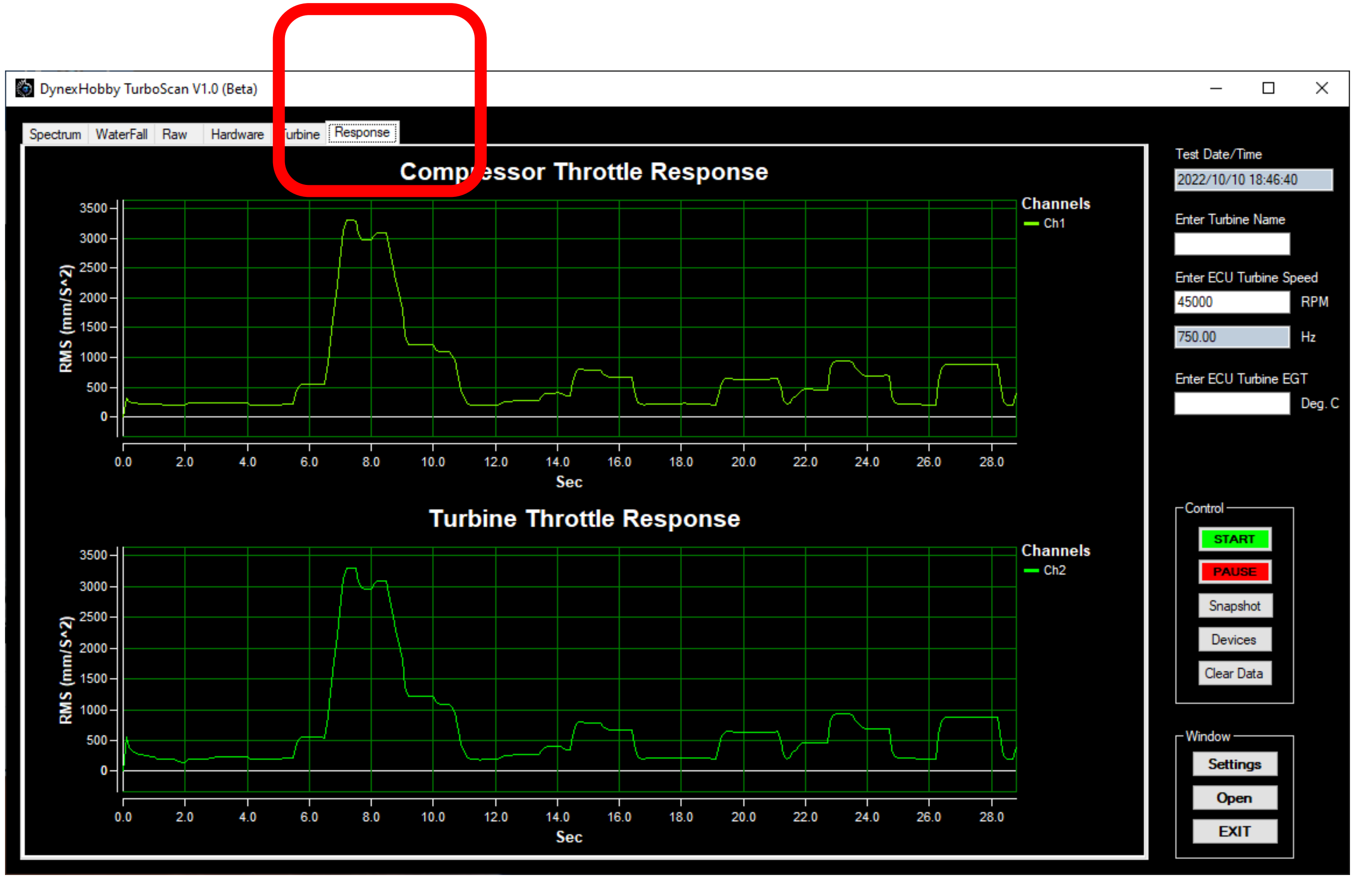
- Hardware setup. Leave as default.
- Turbine tab. Used to define turbine parameters based on engines physical design characteristics.
- Turbine parameters are used to estimate critical frequencies experienced whilst running the engine.
- Note bearing data is difficult to obtain from OEM's, so beware!





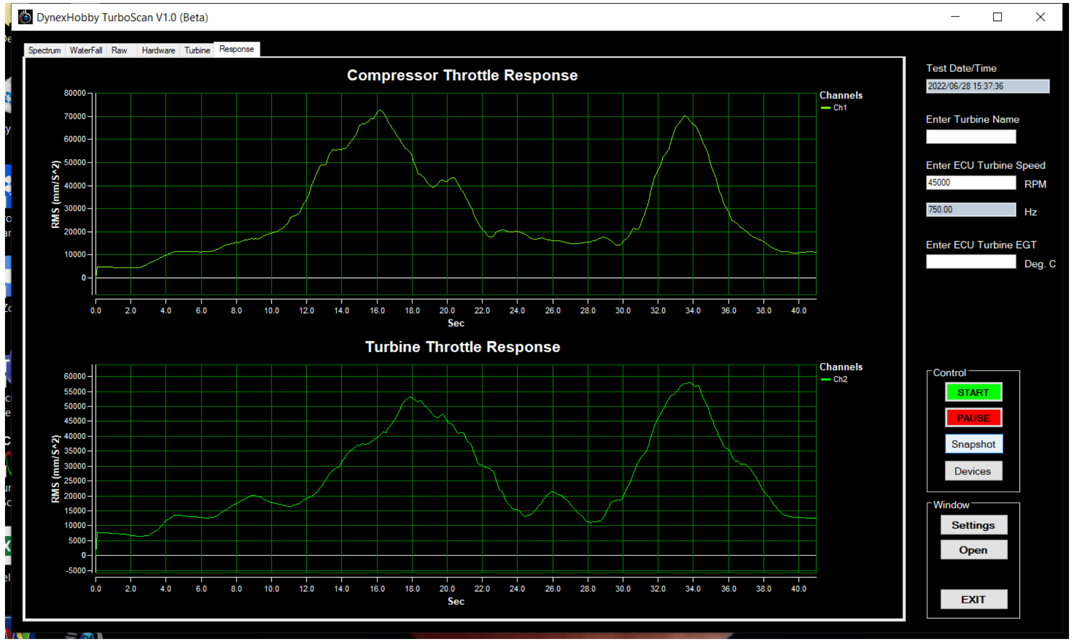
Software

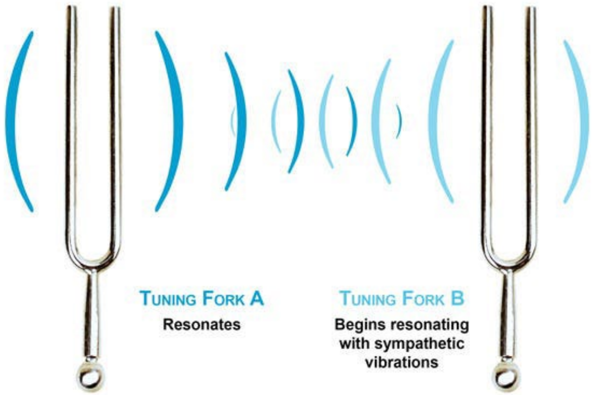
- RMS acceleration can be used for compressor and turbine vibration with changes in throttle settings.
- This is a **time history** measurement so you must know at which position the throttle stick is at during the time interval.
- Useful for identifying **natural resonance**, seen as peaks in the graph.



Engine Resonance

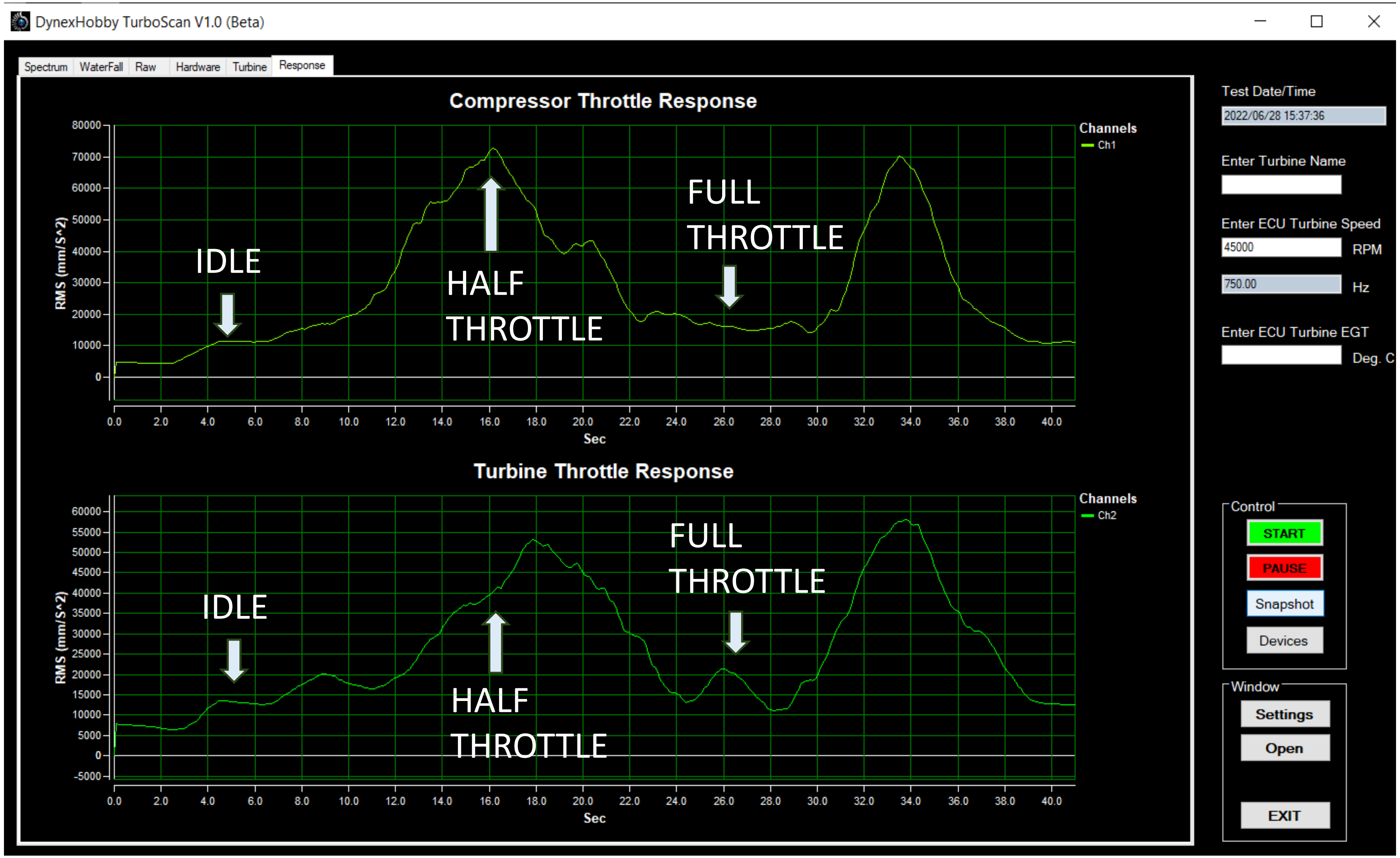
- Every engine has some form of natural resonance.
- This can occur at very specific running speeds.
- When the engine hits resonance it will start to “ring” like a tunning fork.
- TurboScan “Response” indicates where resonance occurs by the peaks in the graph.





Compressor ↔ Shaft ↔ Turbine

Example of Engine Resonance

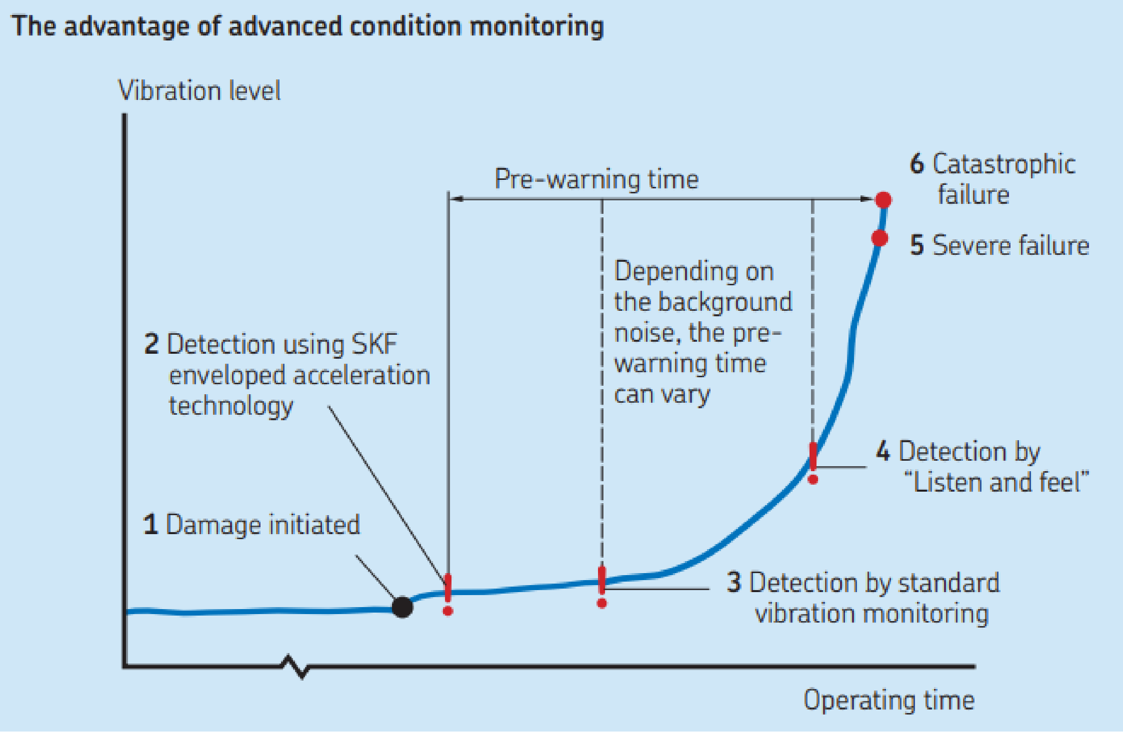


Theory

- TurboScan senses vibration from compressor & turbine housings.
- This can be done under the following conditions
  - Engine driven by compressed air only (i.e. engine not running)
  - Engine running at **Idle**
  - Engine running at **Half throttle**
  - Engine running at **Full throttle**
- The vibrations measured by TurboScan can be due to the following artifacts or defects;
  - Bad bearings (i.e. manufacturing defect, dirty fuel etc.)
  - Bent shafts
  - Bad balance
  - Misalignments
  - Loose compressor/turbine wheels
  - Damaged compressor/turbine wheels, e.g. chips, breakages

Theory continued

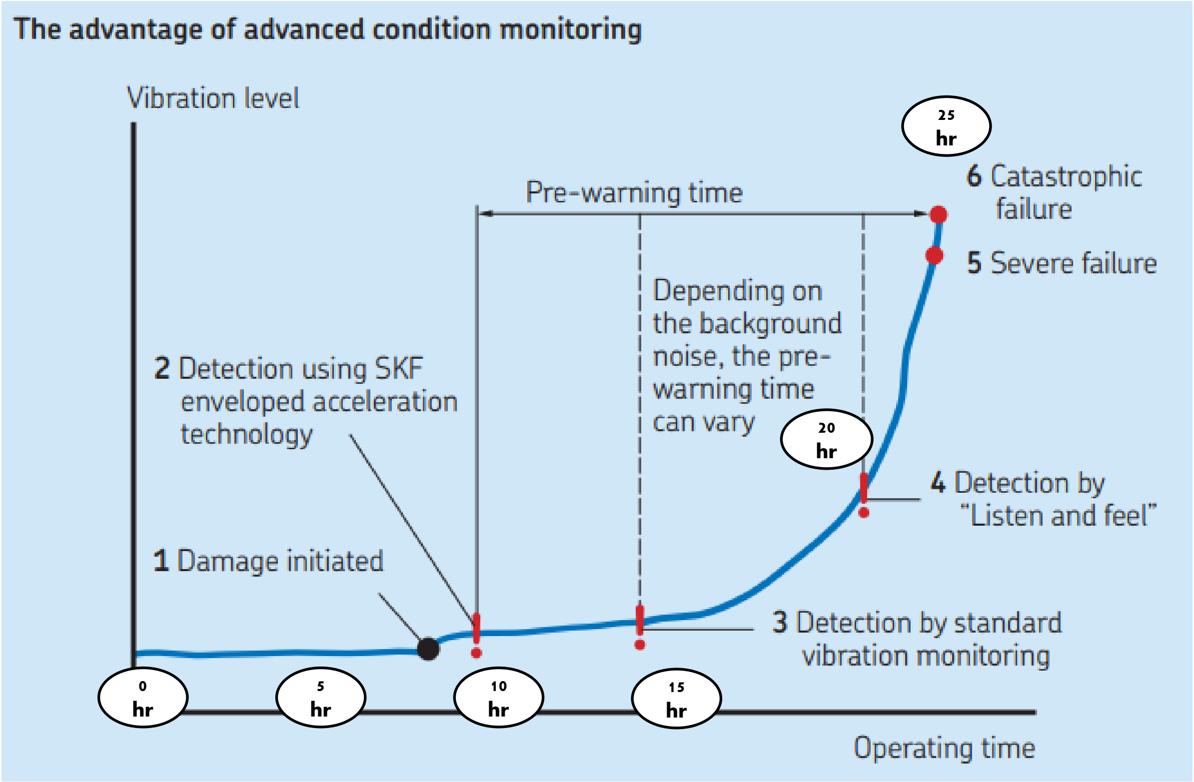
- Vibrations measured are an indicator of imminent failure of engine components.
- Example are bad ball bearings.
- See image →
  - Bearings experience some kind of fault.
  - Fault is felt as vibration through compressor or turbine housing.
  - Fault grows over time until failure of the bearing occurs.



https://www.skf.com/binaries/pub12/Images/0901d1968064c148-Bearing-failures---14219_2-EN_tcm_12-297619.pdf

Theory continued.. Bad Bearings

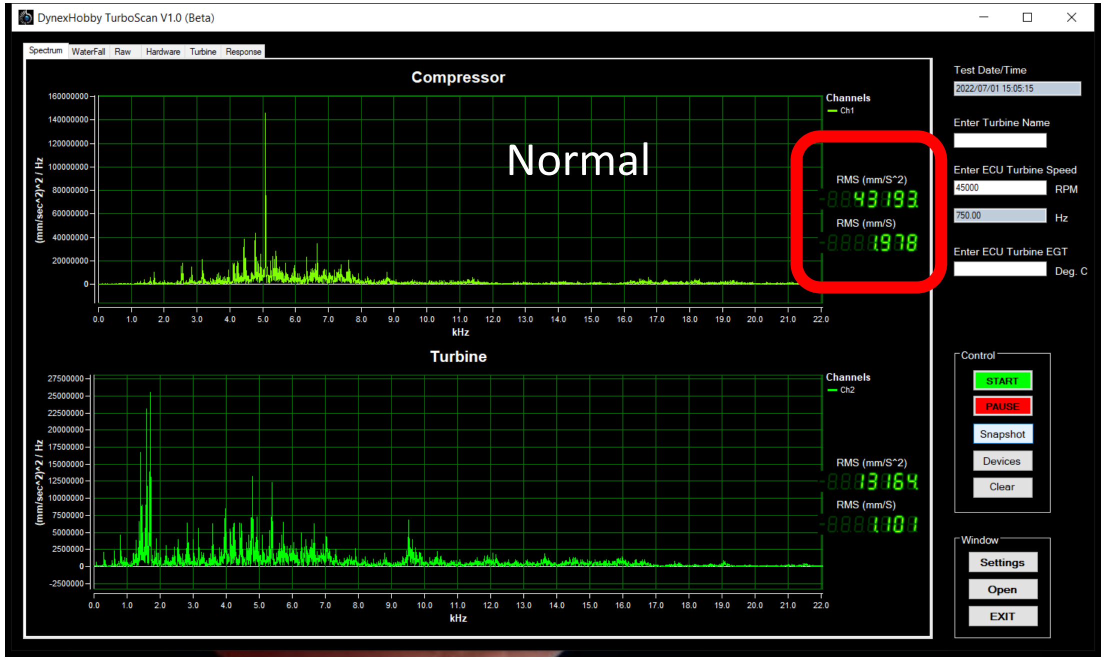
- How do you know when to start paying attention to imminent failure?
  - Difficult to say as failure curves are propriety to engine manufacturers and vary from engine to engine.
  - However, as a rule of thumb, if bearing vibration **increases notably** from the "as new" condition then its time to contact your service representative for engine servicing and follow their instructions.
  - **Warning! To prevent injury, always follow manufacturers instructions for servicing engines. DO NOT operate your engine beyond recommended service intervals.**
  - Due to the uncertainty of when failure can occur, it is recommended to measure engine vibration data every 5 hours of run time. As engines typically have a 25hr run time between servicing, this gives 5 opportunities to inspect for any underlying faults.
  - Map the trend of frequency peaks over time. If additional peaks occur (sidebands) or peak amplitudes increase over time, then evidence of a fault is developing.

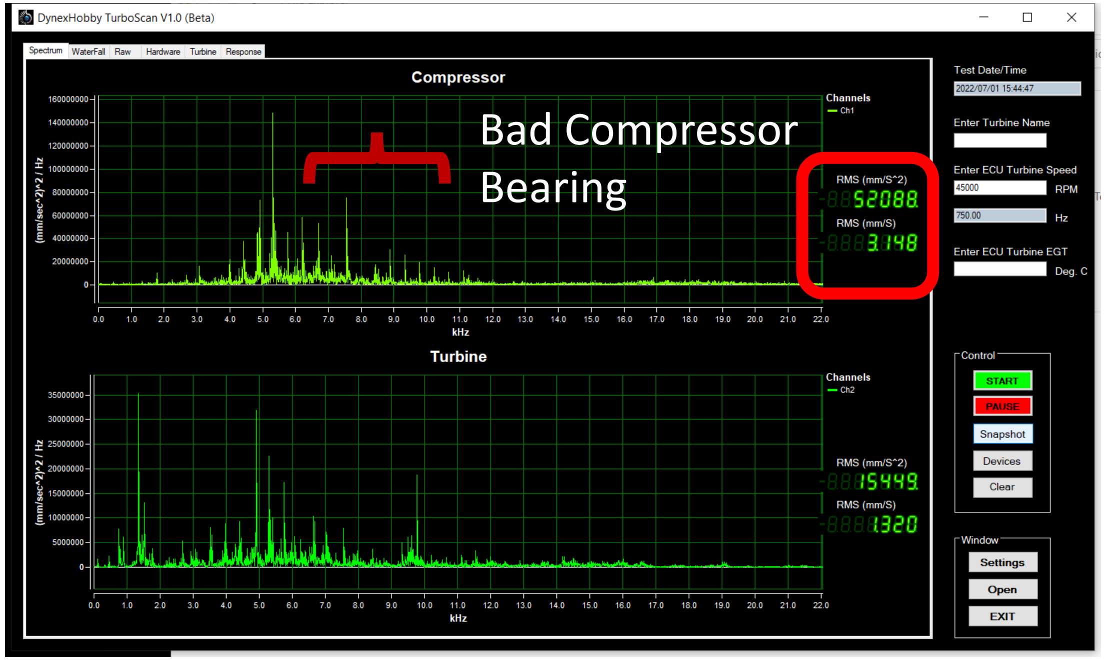


Note: Graph is for demonstration purposes only. It does not represent actual failure curves of engine bearings.

Example of Bad Bearing

- The graph (ABOVE) illustrates the normal running of a micro turbine engine driven by compressed air. The normal run is typically measured when the engine is **brand new** or has **just been serviced**.
- A fault was induced into the compressor bearing and the test rerun **at the same RPM**. The graph (BELOW) shows an increase in RMS values for the compressor PLUS additional frequency peaks.
- The turbine stage also has increased RMS values due to the influence of the compressor.





Thank you!