Shock Finder

How to detect bearing wear/damages at low speeds

Brand of ACOEM

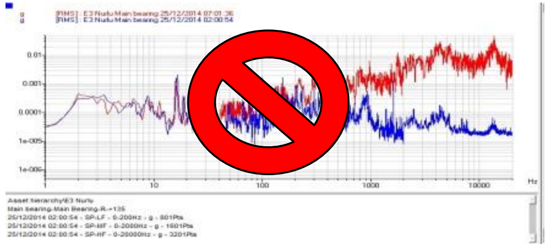
Definition

Automatic shock detection filter

and algorithm providing a warning at a very early stage

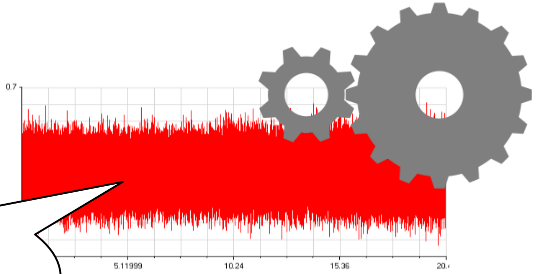
Why the Shock Finder?

Limitations of analysis in the frequency domain



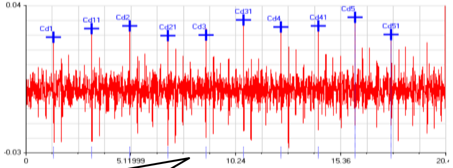
- Not adapted to **variable speed machines** (need stable regime)
- Not adapted to **low speed components** (low energy phenomenon)
- Diagnosis limitations:
  - Modulation vs. periodic shocks: same pattern on the spectra!
  - Multiple pits on a bearing: only 1 harmonic family

Low speed shafts: Hidden shocks



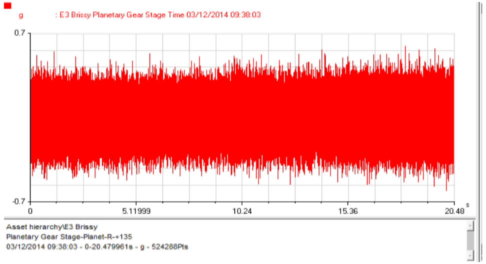
Normal vibrations

+

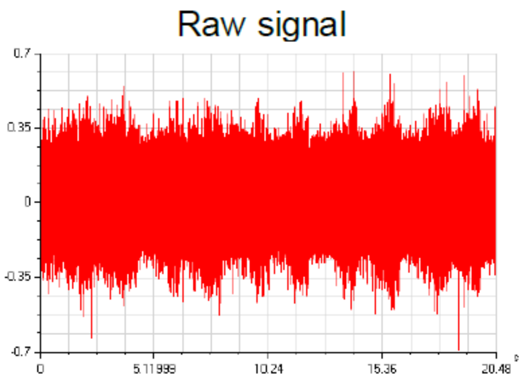


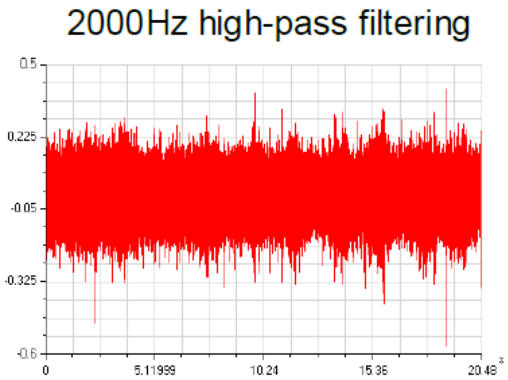
Non stationary vibrations
(what you want to detect)

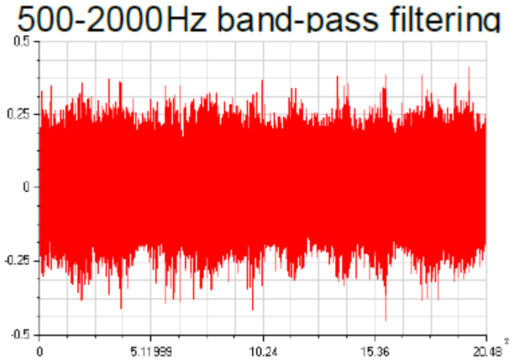
That is what you see !

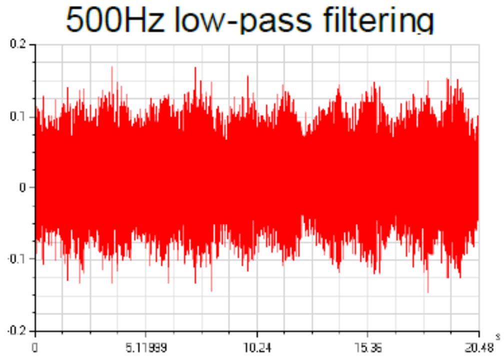


Low speed shafts: Limitations of manual time waveform analysis



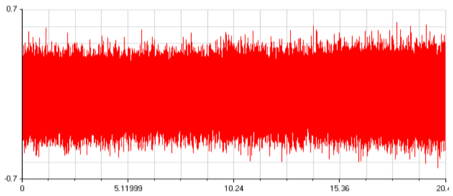




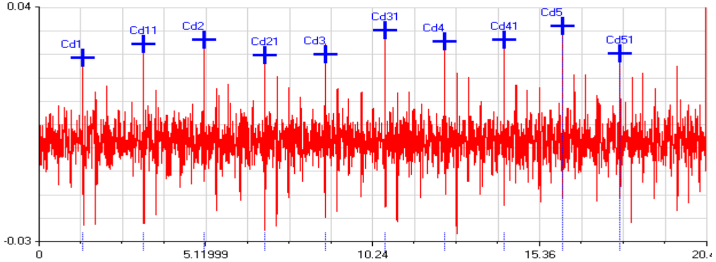


- Where are the shocks??

Low speed shafts: Automatic shock detection with SFI



SFI Filter



Shock Finder

How does it work?

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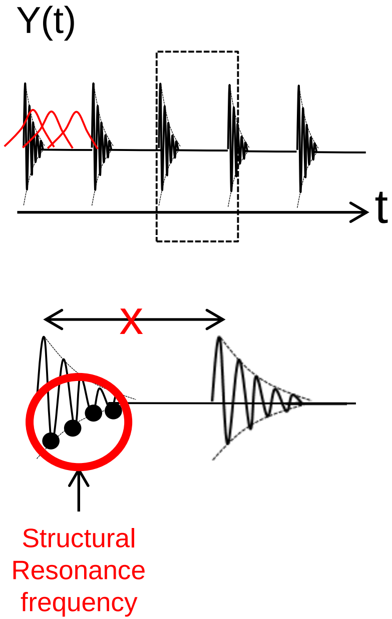
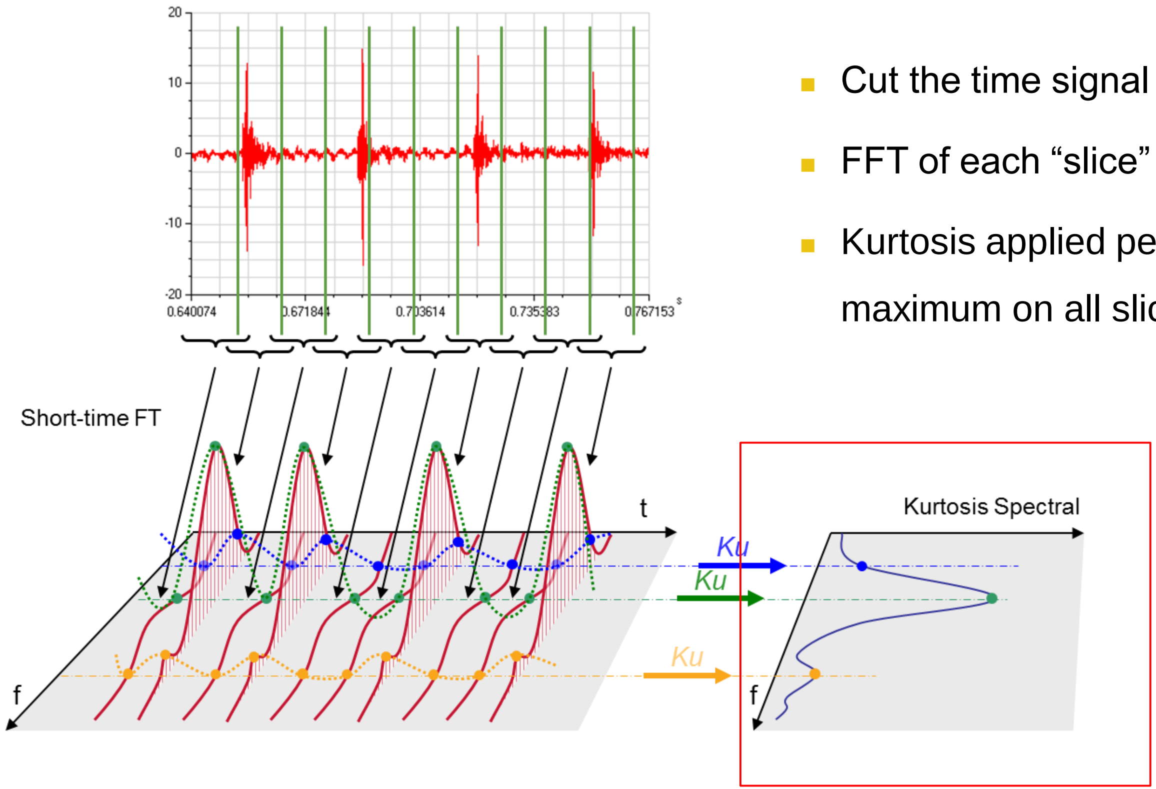
1 – Time waveform acquisition



Detection of abnormal periodic shocks: Need to capture several rotations

Sampling frequency: > 2.4 max frequency signal (Shannon)
<u>≠ of shocks periodicity!!</u>
Bearing defect = up to 10kHz analysis ➔ 25,6 KHz sampling frequency

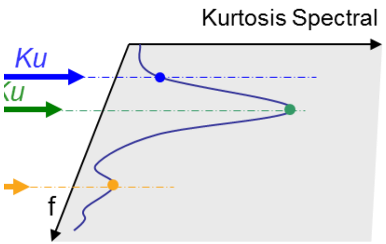
2 – Automatic filter definition with a spectral Kurtosis

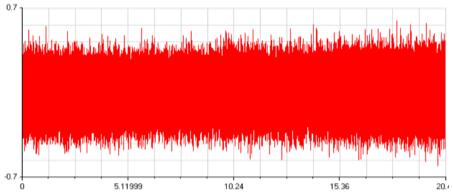


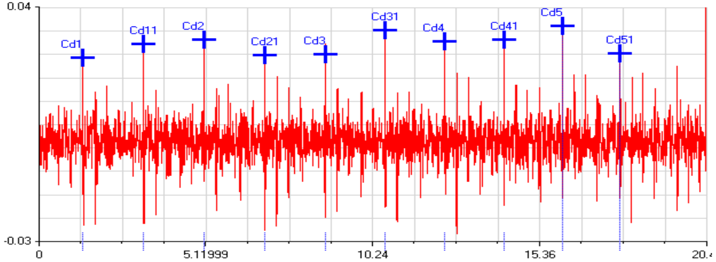
- Cut the time signal in “slices”
- FFT of each “slice”
- Kurtosis applied per frequency band with research of the maximum on all slices = Spectral kurtosis

= Shape of the filter to apply on the time waveform

3 – Filtering of the signal: Remove the normal vibration



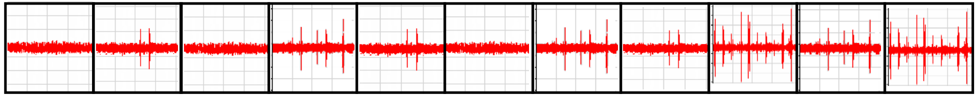




4 – Shock counting & alarm (MVX)

SFI Alarm validation period

Measurement	1	2	3	…							n
Time interval											
Number of shocks	0	2	0	4	2	0	4	2	11	4	11
SFI Flags	0	0	0	0	0	0	0	0	**1**	0	**1**



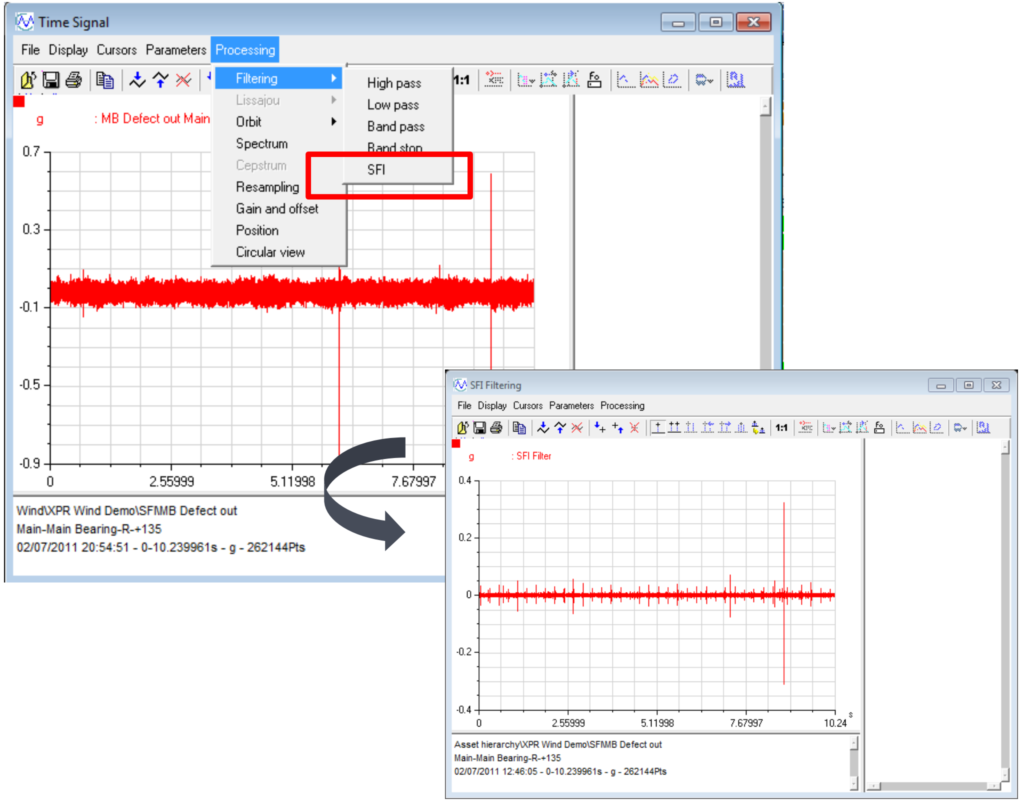
- SFI Alarm is validated depending on:

  - The **total number** of flags that occurred during the alarm validation period
  - The number of flags raised **in a successive way** during the alarm validation period

Shock Finder

How to use it?

1. SFI Filter as a diagnosis tool in Vibgraph



2. SFI Indicator as early fault detection indicator

Monitoring &
Automatic Shock counting

Operating Parameters	Vit Rot	Power	Vent				
	23.6	0.495	6.11				
Filter ◉ All	○ Others	☑ Hard	☑ Soft		☑ Inhibited	☑ Not m	
PSS	Main	Planet	Shaft1	Shaft2A)	Shaft3	GEN_DE	GEN NDE
OVL ACC	0.053	0.469	0.174	0.227	0.804	0.399	0.659
OVL VEL	0.307	0.533	0.422	0.548	0.872	1.77	3.07
En-LF							
En-MF							
En-HF							
FZ							
F0							
Kurtosis							
Shock Finder							

Shock Finder

#17230-SFI-07/02/2011 20:54:51 - 51 Shocks

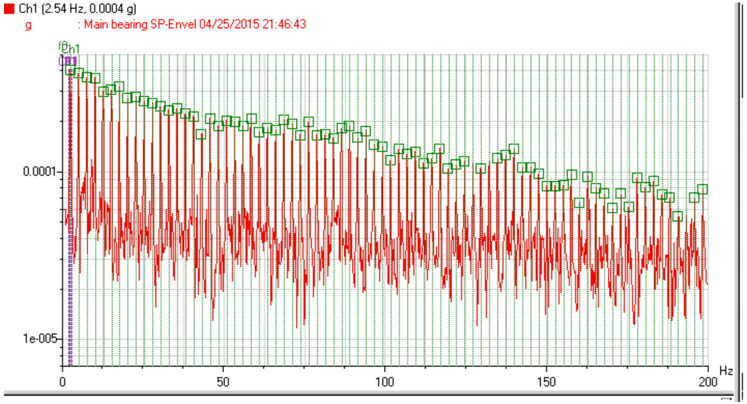
Used automatically by the automatic diagnosis

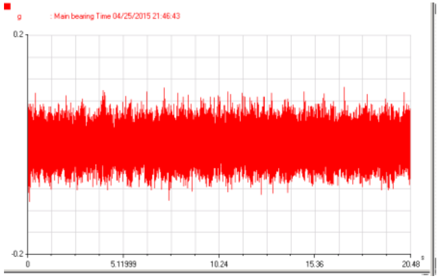
X

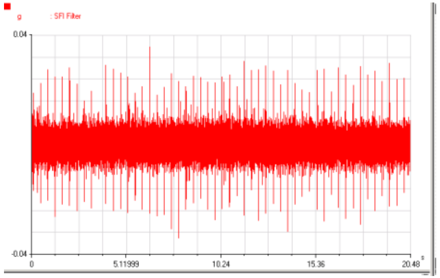
✔

3. SFI as diagnosis tool in complement to other techniques

Good complement to classic techniques (Envelope, Kurtosis…)



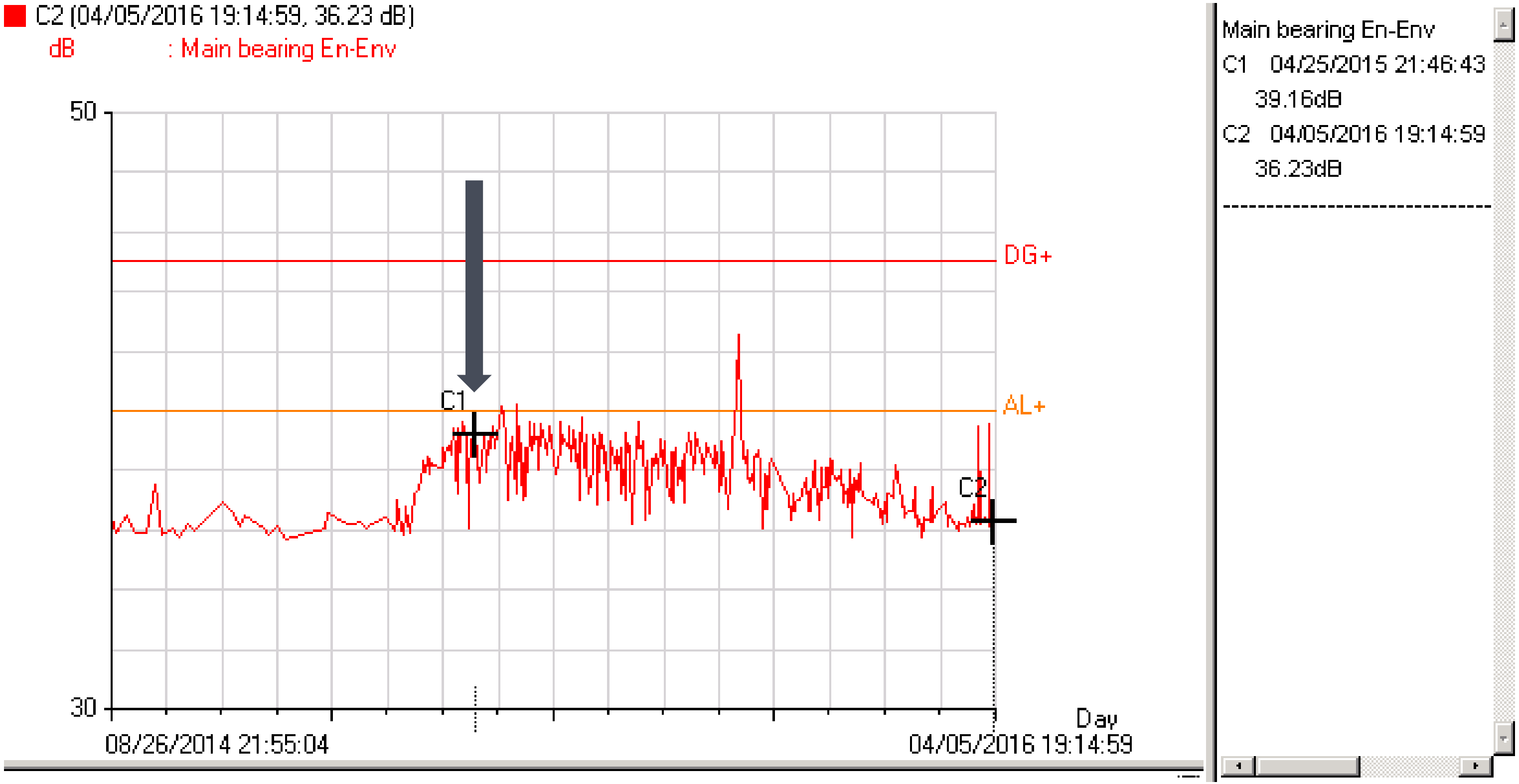




Shock Finder

Few examples

Wind Turbine (MVX) - Main Bearing Defect (1/4)



Wind Turbine (MVX) - Main Bearing Defect (2/4)

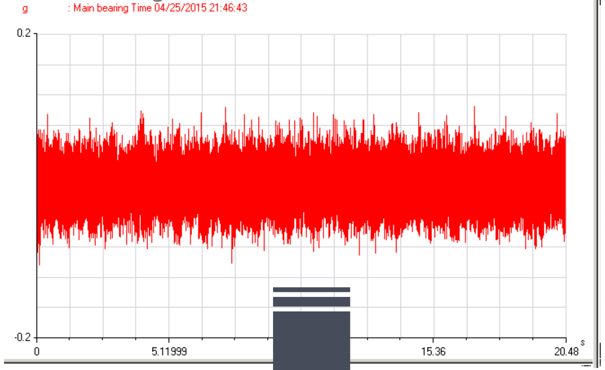
Parameters and Signals Status

Operating Parameters	Rot Sp	Power	Wind
	13.9	6.48	15.7

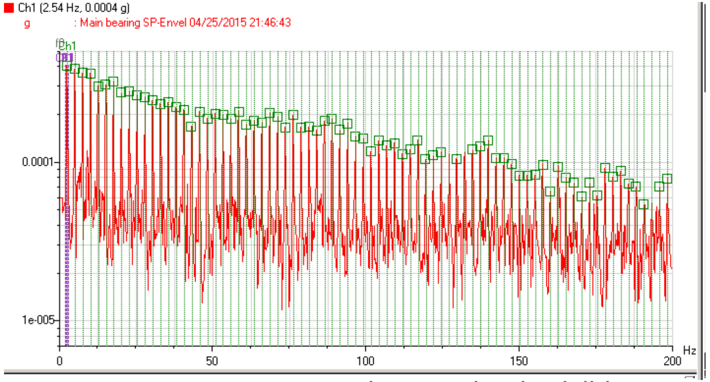
Filter ● All ◯ Others ☑ Hard ☑ Soft ☑ Inhibited ☑ Not monitored

PSS	Main bea	Planetary	2nd Plan	Shaft3	Shaft4 A	Shaft4 R	GEN_DE	GEN NDE
OVL ACC	0.025	0.104	0.073	0.211	0.206	0.215	0.252	0.184
OVL VEL	0.426	0.684	0.829	1.20	0.770	1.68	3.51	2.14
En-LF	0.014	0.030	0.030	0.059	0.036	0.091	0.044	0.029
En-MF	0.019	0.097	0.064	0.190	0.184	0.169	0.029	0.027
En-HF	0.0066	0.024	0.025	0.072	0.091	0.102	0.246	0.177
Kurtosis	0	0	0	0	0	0	0	2.00
Shock Finder								
En-Env	39.2	36.9	37.3	36.9	36.1	35.9	39.0	36.9
F0					0.073	0.533	3.09	1.84
FZ		0.343	0.275	0.153	0.316	0.204		

Time signal

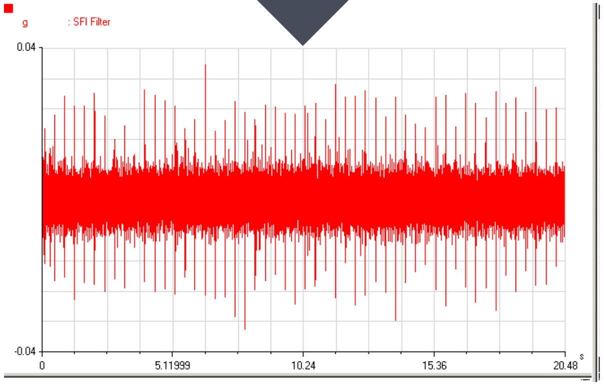


Envelope spectrum



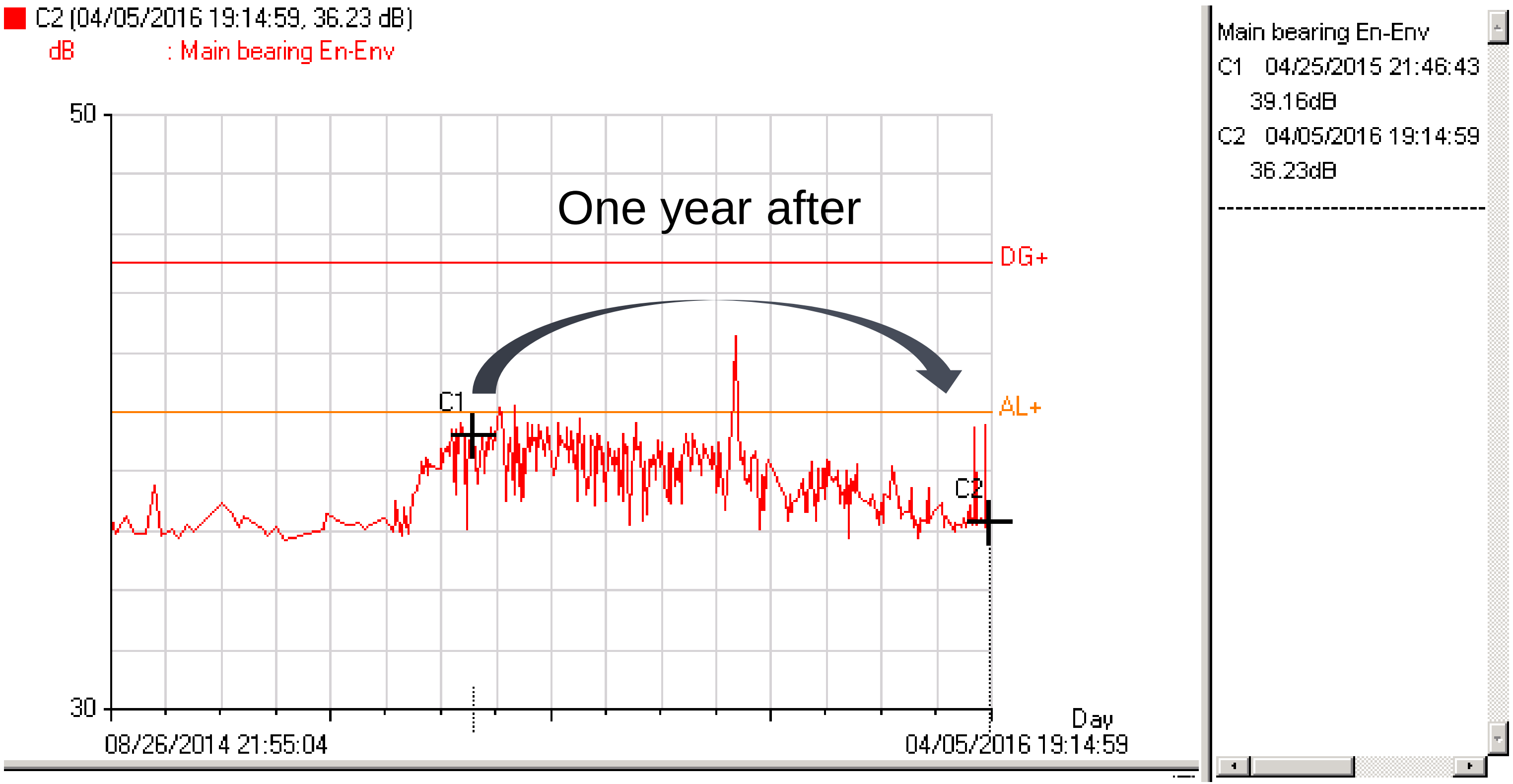
Harmonics are clearly visible

SFI



Shocks are clearly visible

Wind Turbine (MVX) - Main Bearing Defect (3/4)



Wind Turbine (MVX) - Main Bearing Defect (4/4)

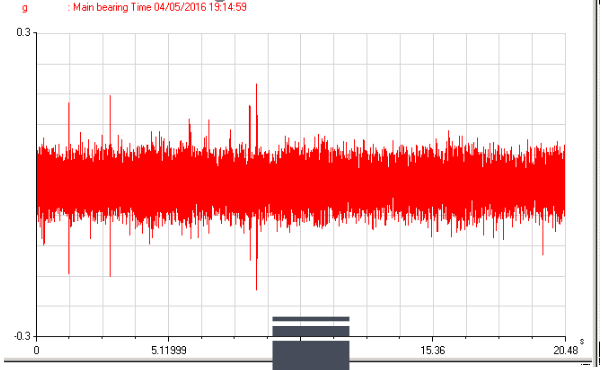
Parameters and Signals Status

Operating Parameters	Rot Sp	Power	Wind
	14.4	10.00	18.5

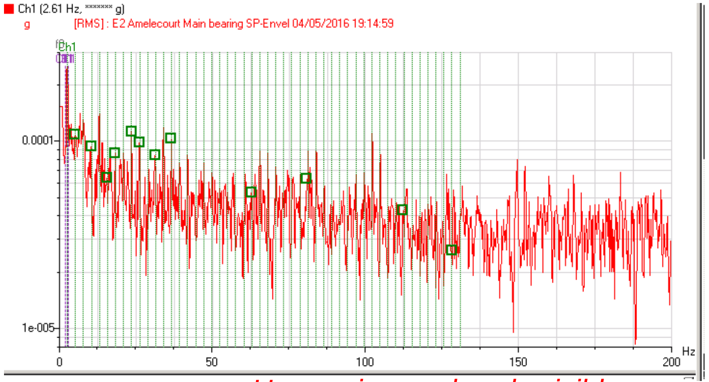
Filter ◉ All ◯ Others ☑ Hard ☑ Soft ☑ Inhibited ☑ Not monitored

PSS	Main bea	Planetary	2nd Plan	Shaft3	Shaft4 A	Shaft4 R	GEN_DE	GEN NDE
OVL ACC	0.029	0.102	0.070	0.229	0.224	0.239	0.226	0.180
OVL VEL	0.864	0.924	1.28	1.44	1.07	1.76	6.10	4.09
En-LF	0.013	0.029	0.027	0.049	0.057	0.097	0.068	0.050
En-MF	0.024	0.096	0.058	0.209	0.182	0.181	0.040	0.033
En-HF	0.0084	0.030	0.028	0.083	0.115	0.120	0.213	0.170
Kurtosis	1.00	0	0	0	0	0	0	5.00
Shock Finder								
En-Env	36.2	36.3	36.3	36.6	36.3	35.9	38.8	37.4
F0					0.072	0.254	4.95	3.11
FZ		0.194	0.192	0.196	0.126	0.302		

Time signal

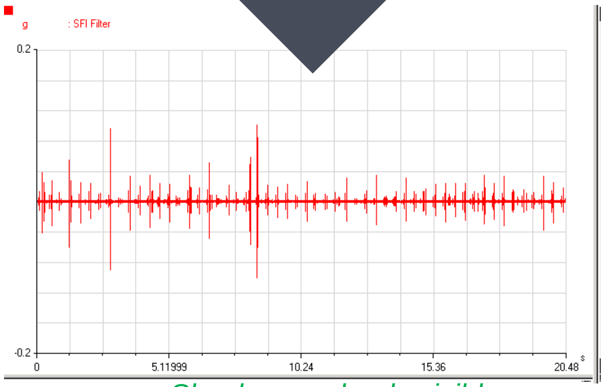


Envelope spectrum



Harmonics are barely visible

SFI Filter

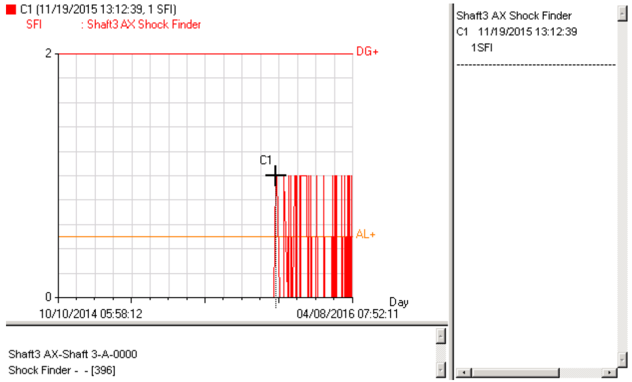


Shocks are clearly visible

Wind Turbine (MVX) – Gear defect

- Shocks corresponding to inner ring defect on gearbox

SFI



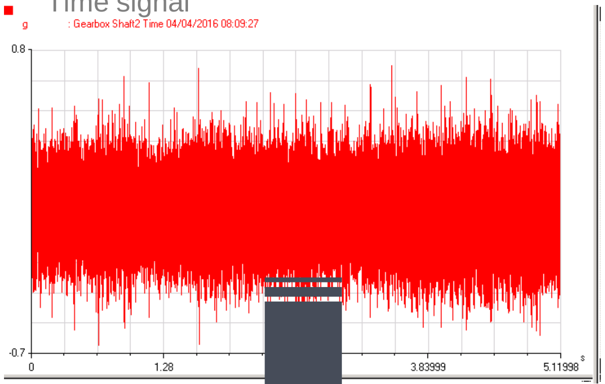
Parameters and Signals Status

Operating Parameters	Rot Sp	Power	Wind					
	1145	294	5.00					

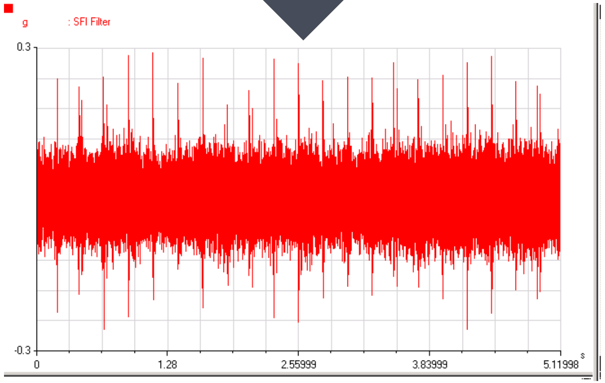
Filter ● All ○ Others ☑ Hard ☑ Soft ☑ Inhibited ☑ Not monitored

PSS	Main bea	2le Main	Planetary	Shaft2	Shaft3 A	Shaft4 R	GEN_DE	GEN NDE
OVL ACC	0.015	0.0097	0.127	0.136	0.151	0.172	0.220	0.275
OVL VEL	0.241	0.173	0.227	0.433	0.353	0.598	0.488	0.782
En-LF	0.0090	0.0050	0.0075	0.0092	0.0096	0.010	0.016	0.024
En-MF	0.011	0.0054	0.068	0.087	0.104	0.075	0.043	0.041
En-HF	0.0065	0.0065	0.100	0.096	0.104	0.152	0.189	0.272
Kurtosis	0	3.00	0	0	0	0	0	0
En-Env	36.2	35.9	36.2	37.0	36.6	36.5	37.7	36.5
Shock Finder								
F0					0.229	0.347	0.108	0.300
FZ			0.025	0.0098	0.048	0.084		

Time signal



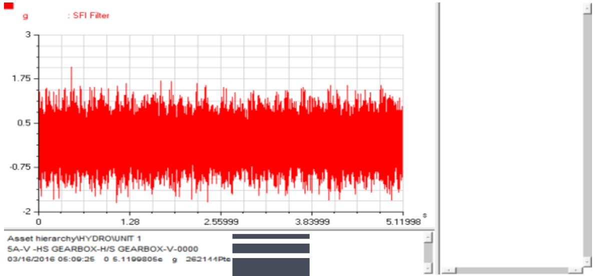
SFI Filter



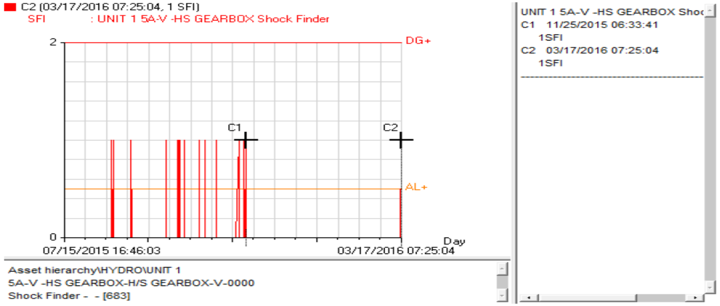
Hydro Turbine (MVX)

- When trash builds up in front of the water inlet it causes the flow to be nonsymetric, and the gearbox becomes out of alignment. This causes the impacts.
- The High Speed Planet Passage frequency is 16.1 Hz Hz and that is the repetition rate of the impacts.

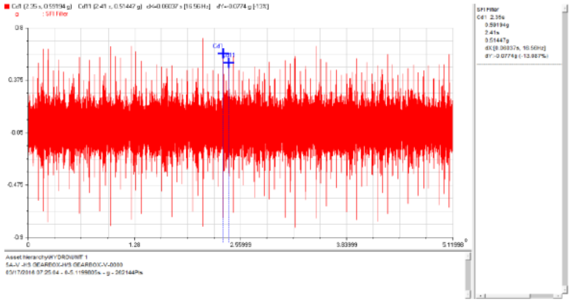
Time signal



SFI Trend

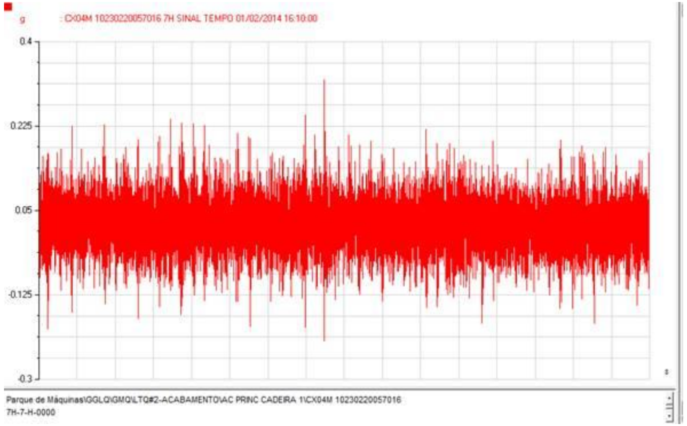


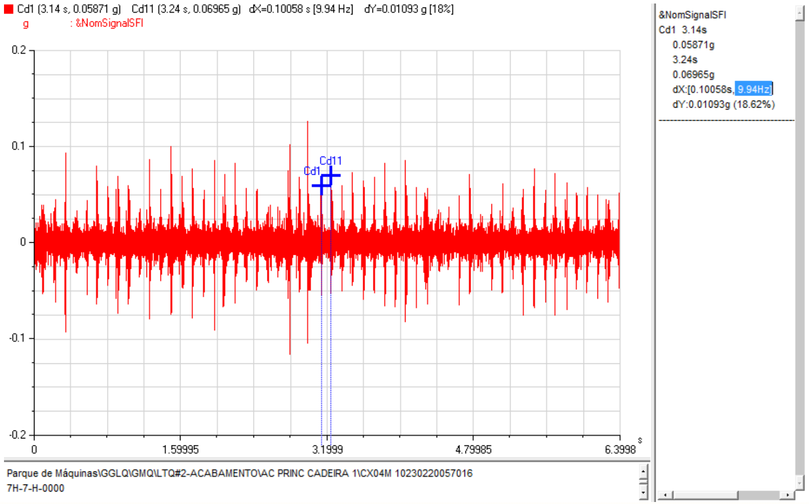
SFI Filter



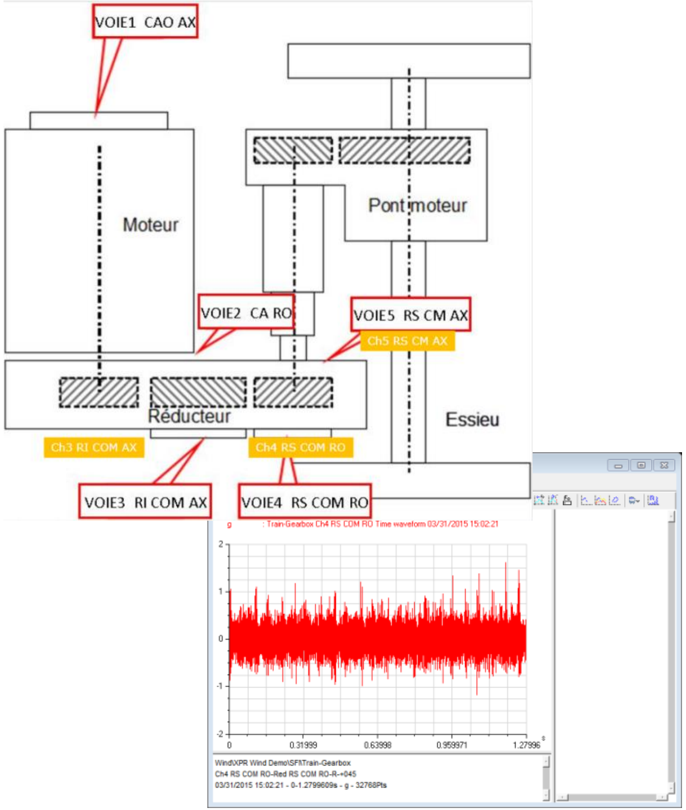
Laminating machine (MVX)

- Bearing defect

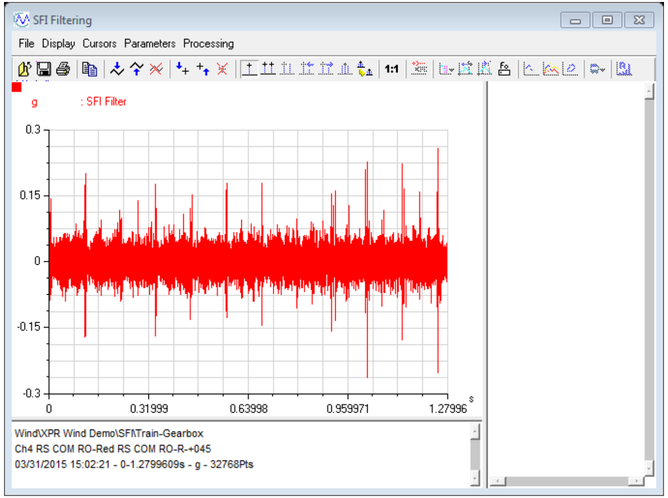




Measurement on a train gearbox (Vibgraph filter)



- Bearing defect



Shock Finder

Conclusion

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Shock Finder: The benefits

- **Reliable detection for low speed and variable process** (speed, load)
- **Reliable detection in the low frequency domain** (gears)
- **Easy to use**: No need to define filters parameters
- **Cost effective installation**:
  - Use of standard accelerometer
  - Only one sensor for both unbalance phenomena and ball bearing defect
  - No need for phase measurement with a tachometer
- **A big + for diagnosis purposes:** easy confirmation of the results shown by classic techniques (Envelope, Kurtosis…)

Representerar OneProd i Sverige!