Experiences from motion amplification measurements at Loviisa site

Vibrations in nuclear applications 2019, Seminar, Energiforsk

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AGENDA

1. Introduction
2. Vibration measurement equipment
3. Measurements with high speed camera
4. Example videos
5. Conclusions

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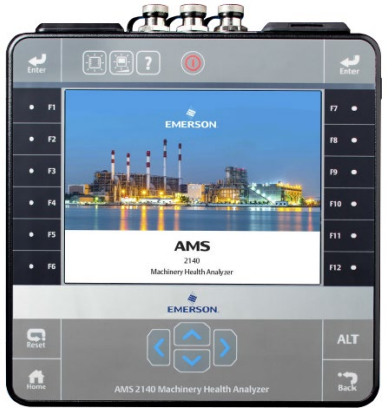
1. Introduction

- High speed camera was rented for around two weeks from MLT Finland Oy with 1½ day training
- Recordings were done for 4 EDGs. In total 150 videos were recorded.
- Typical recording session was around 1 hour which resulted 10 videos
- Normal indoor lighting, for instance fluorescent lamp flickers at 50 Hz grid frequency, which disturbs video recording.
- Typically at rotating machines 50 Hz frequency is the interesting one (1500 rpm = 25 Hz = 1xN, 2xN = 50 Hz ; 3000 rpm = 50 Hz = 1xN)
- Therefore most of the recordings were done in dark and lighting was with two LED spot lights

2. Vibration measurement equipment

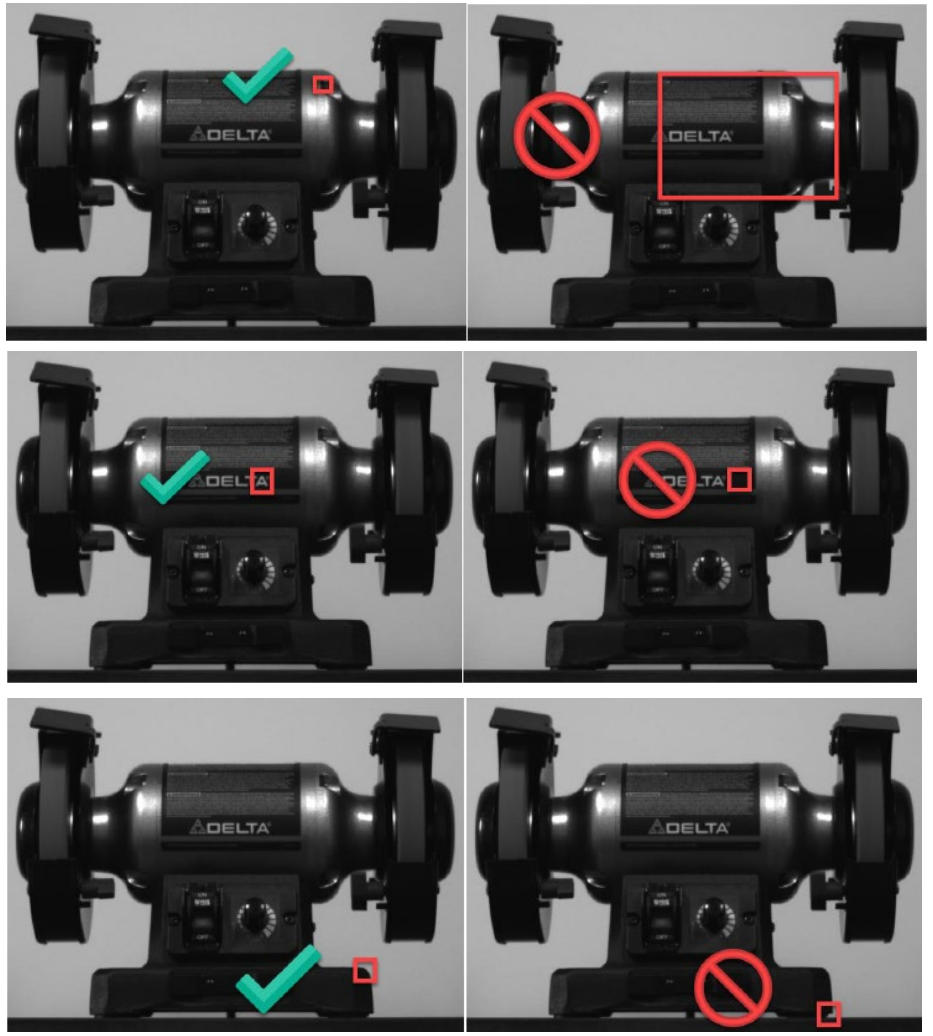
- Traditional vibration measurements with 4-channel CSI 2140
  - Measurements with accelerometers
    - Acceleration, time signal 5 sec for excitation calculations
    - General vibration levels (Vibration velocities in mm/s)
  - Accelerometer + impact hammer
    - Hammer test for eiqenfrequencies



- High speed camera, IRIS-M
  - Practical frame rate capability 100 – 525 fps => Maximum frequency ~ 50 Hz – 250 Hz
  - Measurements can be done from the image (displacements, vibration velocities)
  - Waveform, spectrum and orbit plots

3. Measurements with the high speed camera

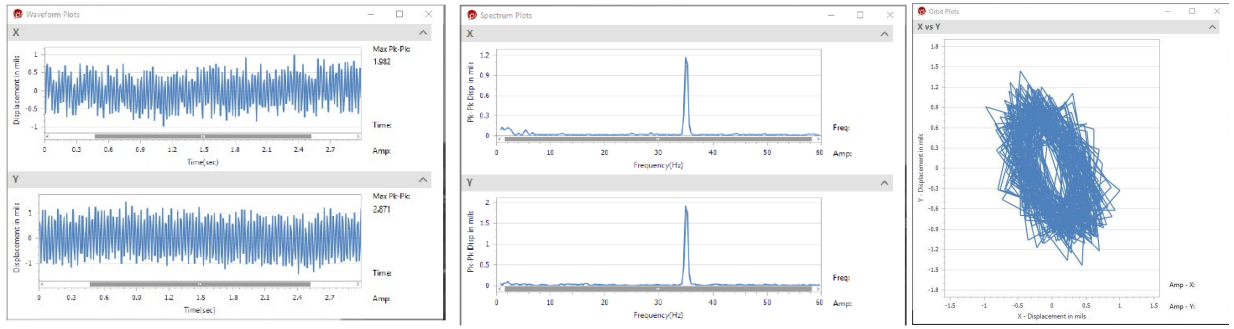
- For vibration measurement results a Region of Interest (=ROI) is drawn to image. There can be several ROI's in the image.
- In practice algorithm follows displacements for group of pixels inside the ROI. Vibration velocity and acceleration can be calculated from the displacements.
- A good ROI-area is small, has a good contrast and only one object/component in motion.
- In practice the ROI's have to be decided on the field. The camera distance for the target has to be known for accurate measurements. The easiest way to measure distance is with laser before the recording.
- Results can only be calculated in plane, horizontally (X) and vertically (Y), not in the depth.

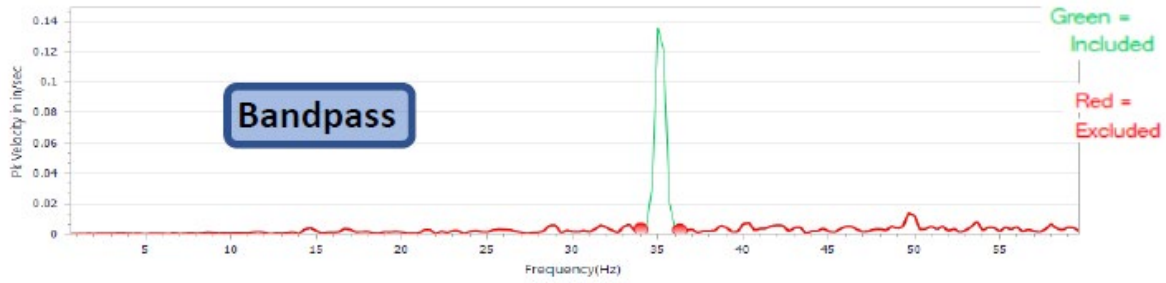


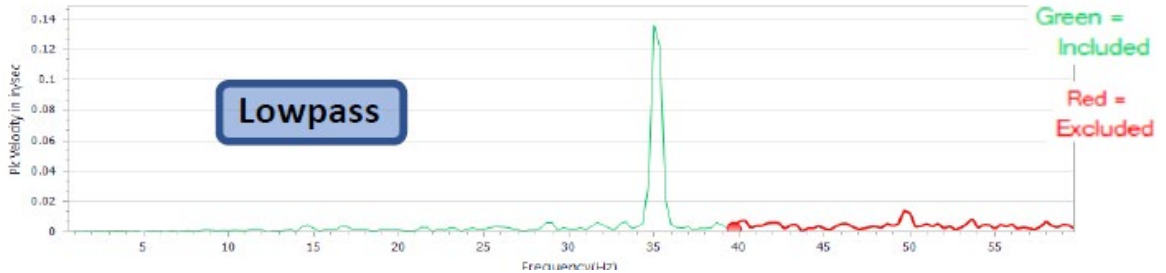
Source: IRIS-M Manual

3. Measurements with the high speed camera

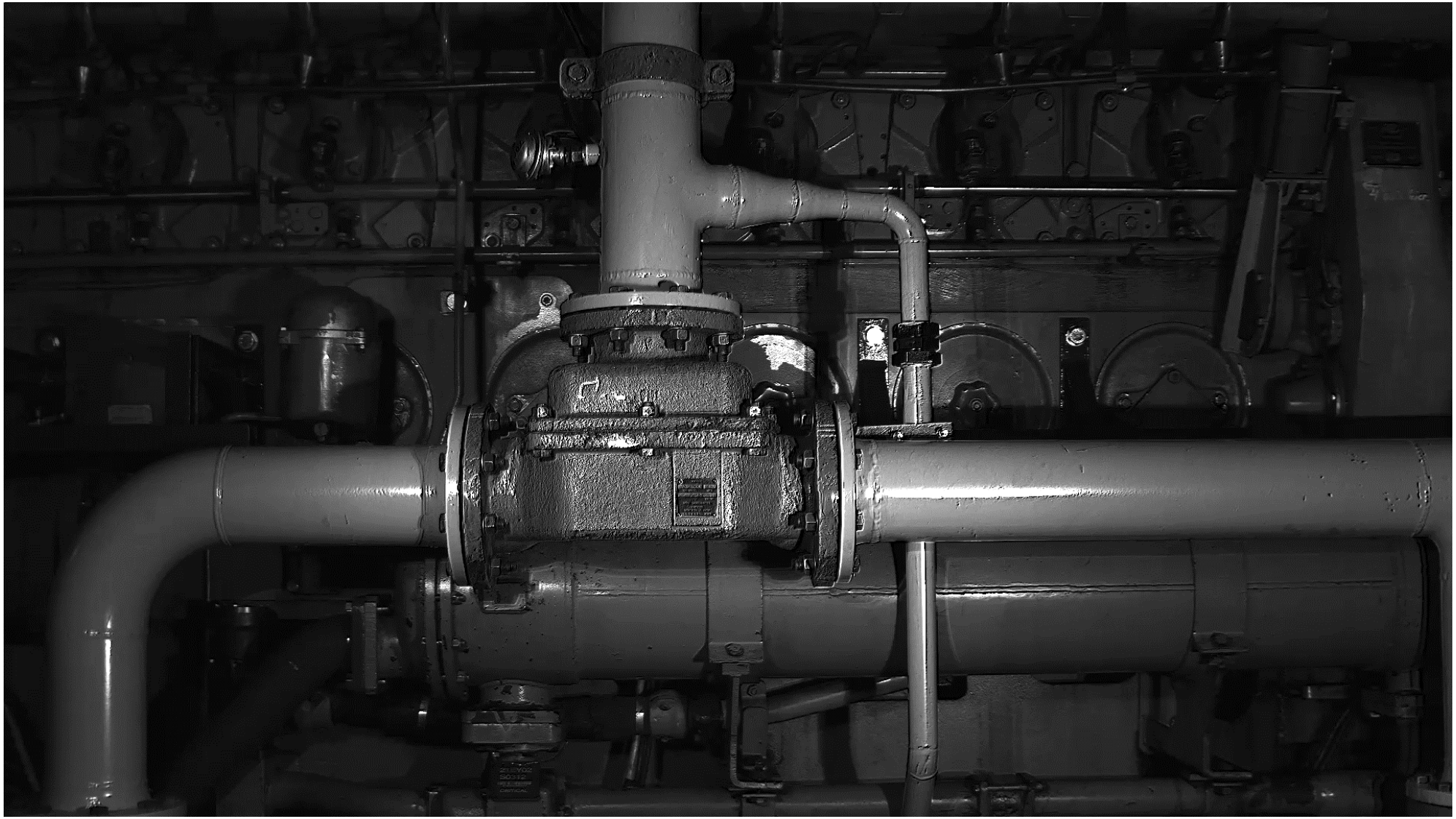
- Results can be plotted in waveform, spectrum and orbit format.
- Possibility to use also filters like bandbass, lowpass etc.
- Amount of amplification can be adjusted, from zero to 50 times.
- Typically 25 amplification was used.



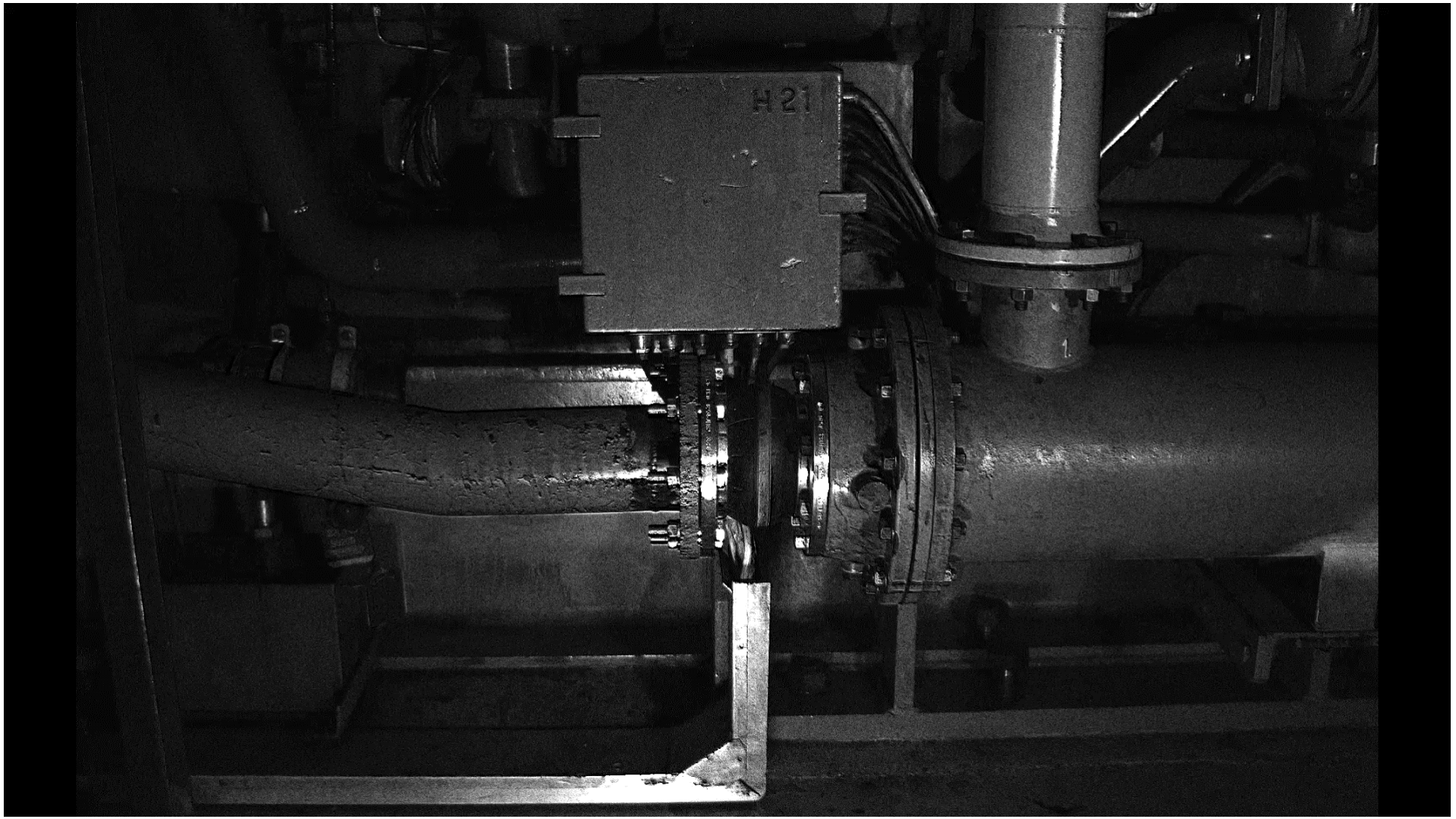




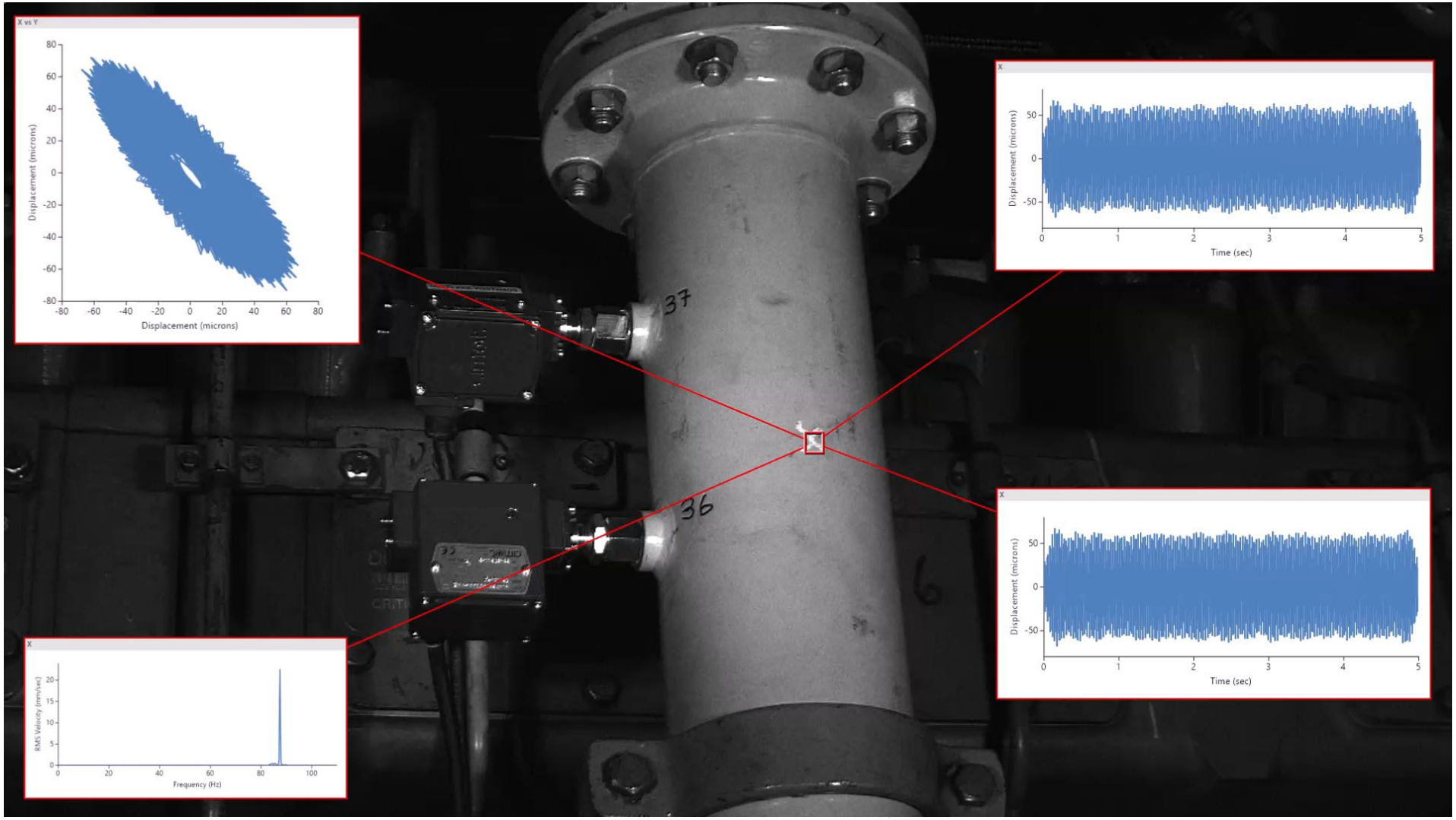
4. Example video 1



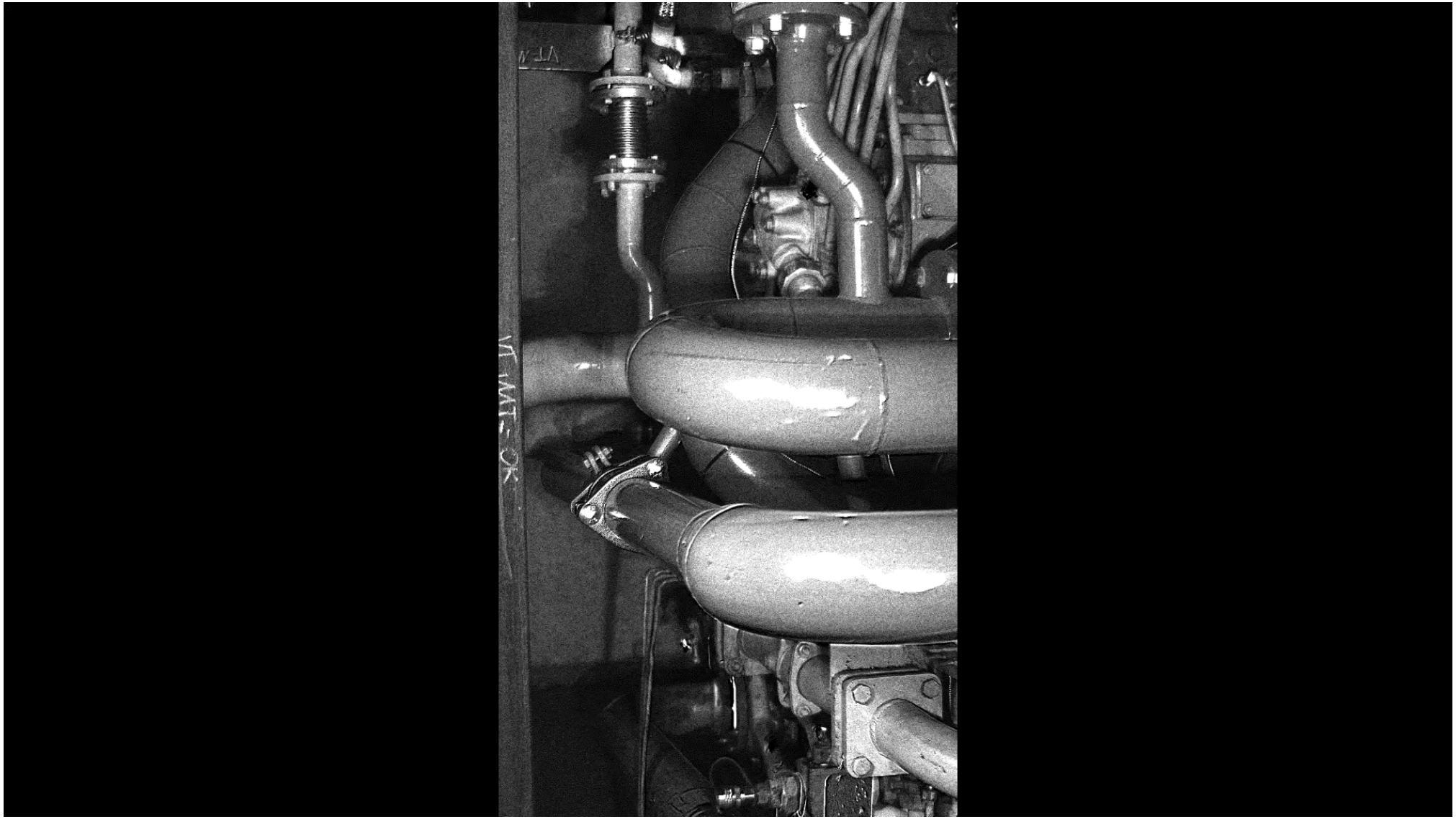
4. Example video 2



4. Example video 3



4. Example video 4



Conclusions

Benefits

- Relatively easy to get started with few days of practical training.
- Most important benefit is to see how components / parts/ piping / supports move in relation to each other. Root cause is often visually seen.
- The results are easy to show, share and discuss also with manager and director level.
- Measurements are totally non-contact, since the person acquiring the data never has to actually touch the machine.

Challenges / drawbacks

- Lighting is always challenging
- Basic and even advanced photography understanding is needed for improved quality and consistency.
- Limited frequency area, also possibility to miss some phenomena/movements
- Comparison measurements might not be so easy to do. Same angle, distance, settings, lighting etc. are not so easy replicate.

Thank You

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