MOTIVATION

Hypersonic AI Sensor

POWER IN THE PALM OF A LAYMAN

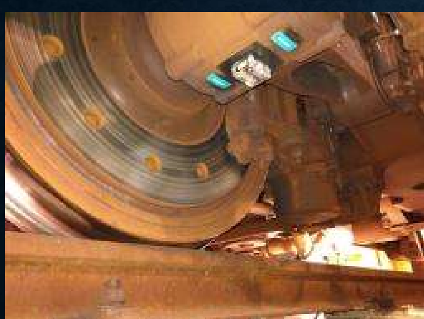
TO MONITOR DIFFICULT TO ACCESS STRUCTURES

Two main goals:-

1. To design a sensor with the least amount of configuration so that even a layman or technician can use it.
2. To be able to install it in highly remote locations (such as a railway track) that you don't need to maintain it for another 7 years or so.

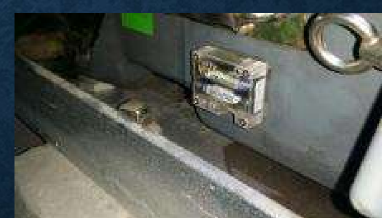
Welcome to: Our Hypersonic Fusion Sensor which is a fusion of 13 sensors into 1 device with AI streaming technology.

Range of applications:



Axlebox

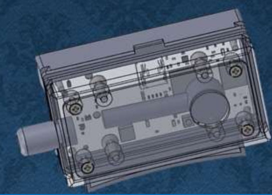
Overheadline



Point Machine

Bogie

MARKET COMPARIZON



Hypersonic AI Sensor

Competitor Products	Our Fusion Sensor	Technology
1. Low sampling rate	Sampling rate of up to 1 million samples per second	Sensor direct memory access to CPU memory
2. Single sensor value	13 sensors in 1	Multiple range vibration and acoustic emission
3. Bulky, multi devices put together	Single device	
4. Last a few hours due to high power consumption	Battery life: 7 years or more	Own MTR-OS for extreme power saving
5. Long cables (costly)	Cableless design with flexibility to connect to external power supply	High density battery technology
6. Large size for acoustics	World's smallest integrated acoustic data logger	High density PCB design
7. Long setup time > ½ hour	Short setup time of only 1 minute	User friendly user interface
8. Calibrate by lab every year	Auto calibrate saving yearly costs	ISO 16063 gravitational technique
9. High purchase cost 15k to 30k or more (HKD)	Low purchase cost of only 3k (HKD) – encourage you to install more for big data	Made in Hong Kong
10. High monthly 4G operating fees	Zero operating cost	LoRa RAW (self developed protocol)
11. High latency of 1s to 10s	Low internet connection latency ~10ms	Custom 10 pipeline gateway
12. Easy to have wrong sensor selected e.g. used 2G but vibration is 20G	Auto select the sensor range so even if you used the wrong sensor, it will auto correct	Fusion algorithm software
13. No automatic fault detection abilities	AI based spike defect detection	Streaming analytics
14. Sometimes they fail and lose data	Self recovery from a fault in 1ms time	TUV certified technologies (e.g. safety critical file system)

SHOWCASE

Hypersonic AI Sensor

1. **This is the Webapp** that controls the device. It was designed using Vite and Web-bluetooth. Which means all the layman needs to do is just visit the web address fusionsensor.org, the app will auto download itself into your device in ½ a second.
2. **At the end of the day, there is:**
   - No cloud setup
   - No app installation
   - No data analytics know how
   - No special installation needs
   - No cable power source
   - No router setup
   - No calibration

You can control things like:-

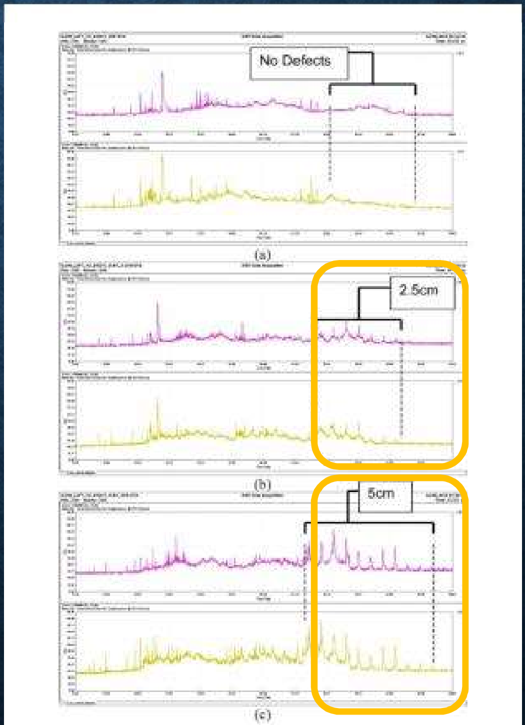
1. Program the Sensor ID
2. Synchronize the clock with your mobile phone
3. Conduct a health check
4. Schedule when you want the sensor to turn on or off every week or every month to save power
5. Sleep the device when there is no vibration
6. Ways of wireless transmission
7. And lastly, we can tell it to do AI training; then run the AI model immediately.

NONE OF THESE - JUST PLUG AND PLAY BUT WITH HIGH PRECISION RESULTS.

APPLIED FOR TRAIN WHEEL FLAT DETECTION

Take for example: we can detect train wheel flats using our device. The red lines are vibration and the yellow lines are acoustics. In this diagram you can see that when the wheel flat is around 5cm wide, there are a lot of spikes in both vibration and acoustics. If there is no wheel flat, there are no spikes.

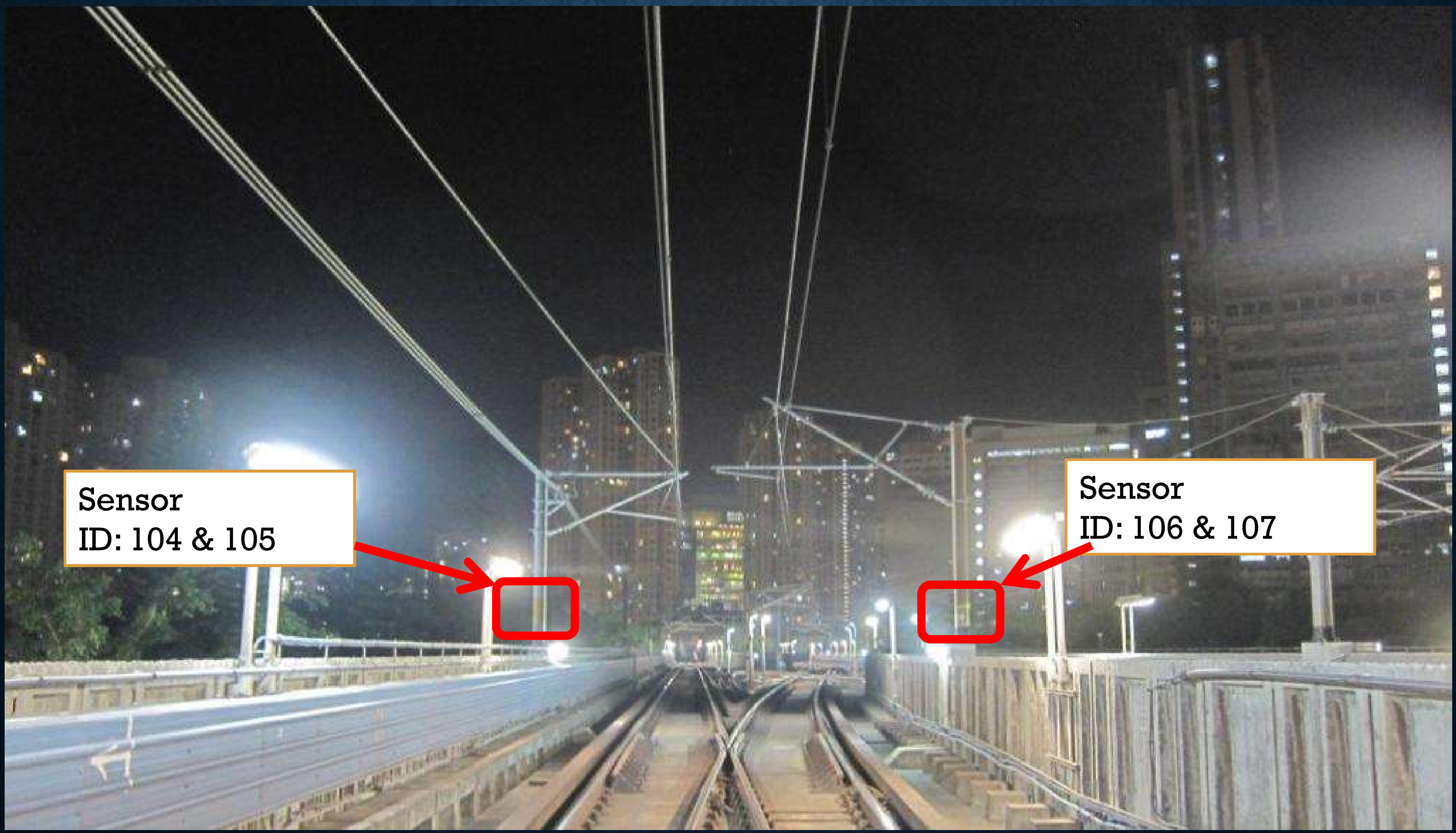
Track installation



The acoustic sensor we used is 300kHz hypersonic frequency which is 15 times the frequency of audible sound.

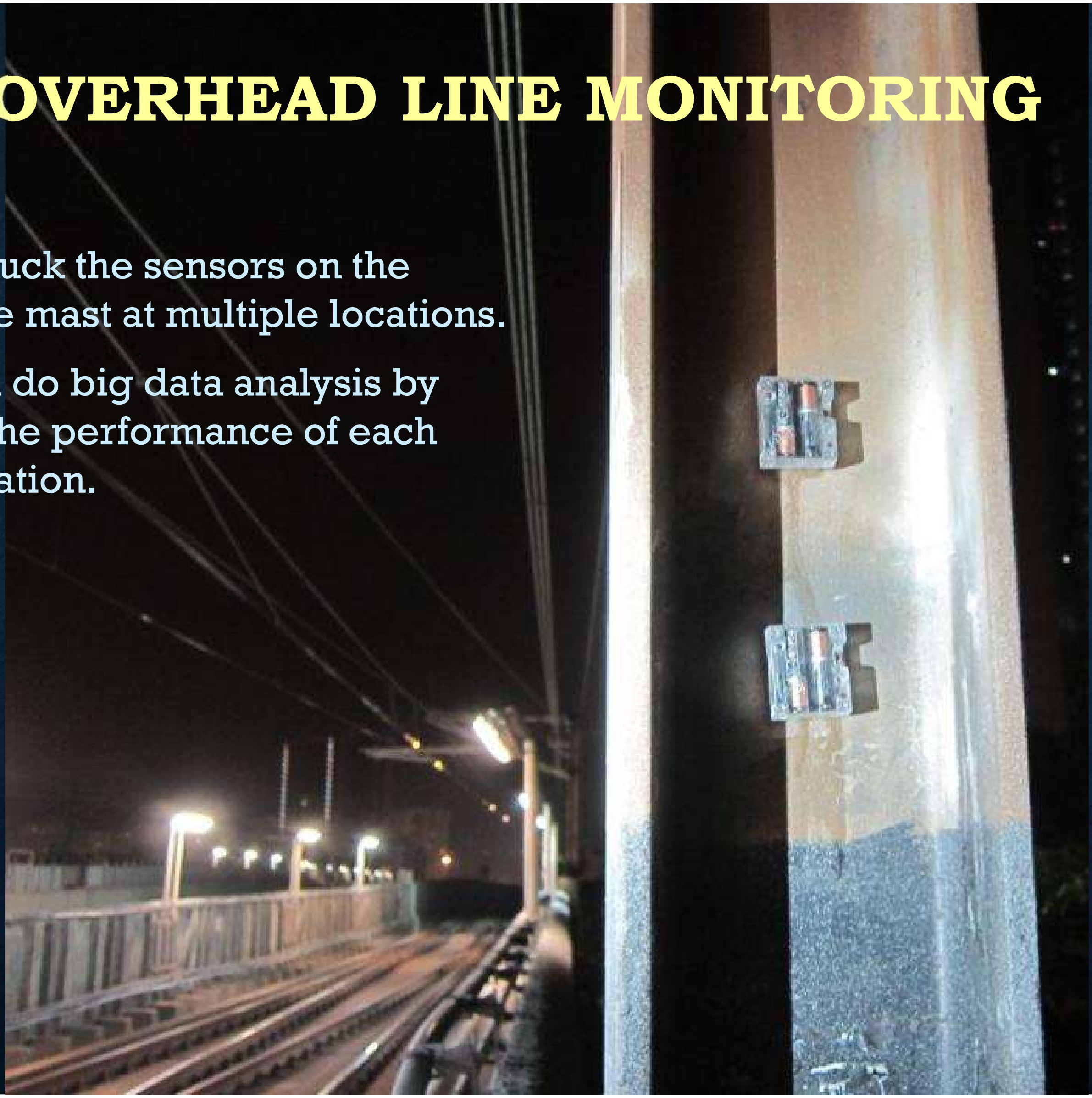
The advantage of using acoustics is that even if the train is slow, we can still detect the spikes whereas vibration is low.

APPLIED FOR OVERHEAD LINE MONITORING



OVERHEAD LINE MONITORING

- Where we stuck the sensors on the overheadline mast at multiple locations.
- Then we can do big data analysis by comparing the performance of each different location.



Clevis Clamp

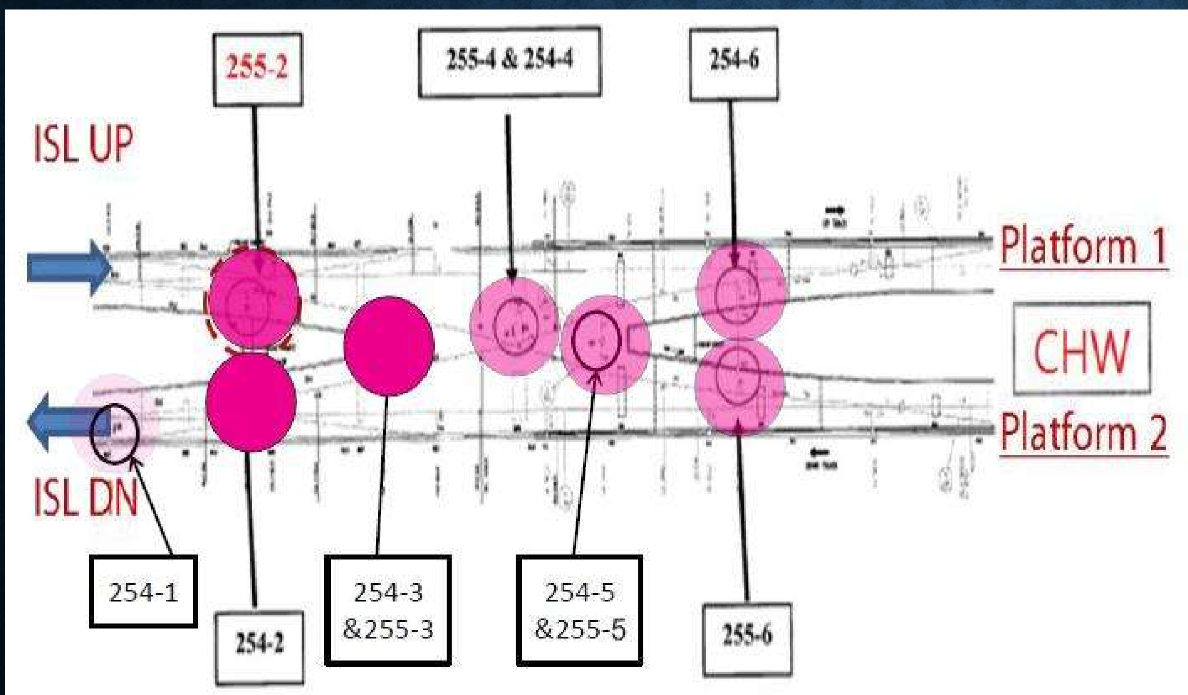
Insulator

Mast Top

Mast Bottom

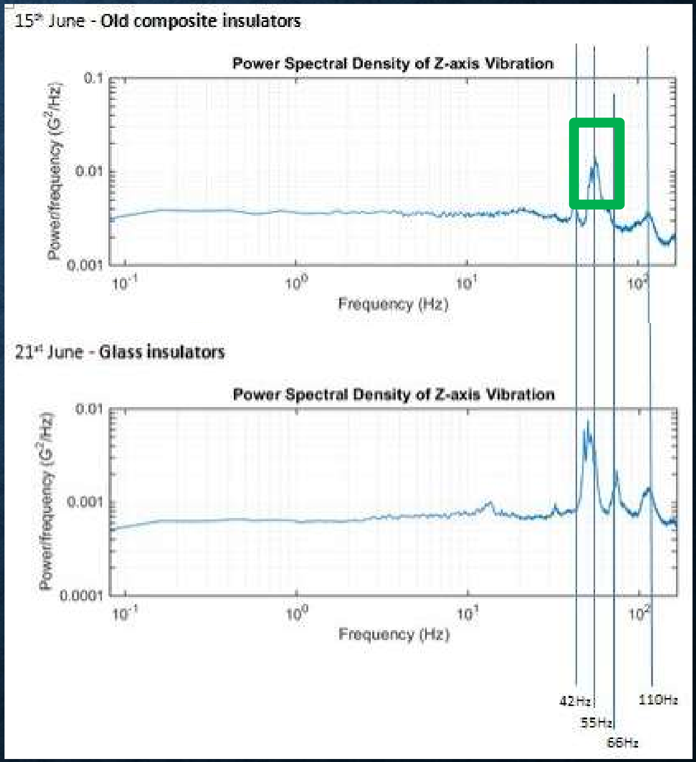
OVERHEAD LINE MONITORING

- Then we did big data analysis to compare the vibration across different locations. This helped us to determine which masts were likely to fatigue and why. The dark red areas are ones with relatively high vibration, the light pink areas are ones with low vibration.



OVERHEAD LINE MONITORING

- One of the solutions to reduce vibration fatigue was we used composite insulators which you can see using Fourier analysis that composite material have lower resonance compared with glass material.



OVERHEAD LINE MONITORING

- And finally we modified the entire structure of the mast completely which reduced the vibration even further.

FATIGUE ANALYSIS

- The last example I want to show you is a train mirror that keeps on breaking over here.

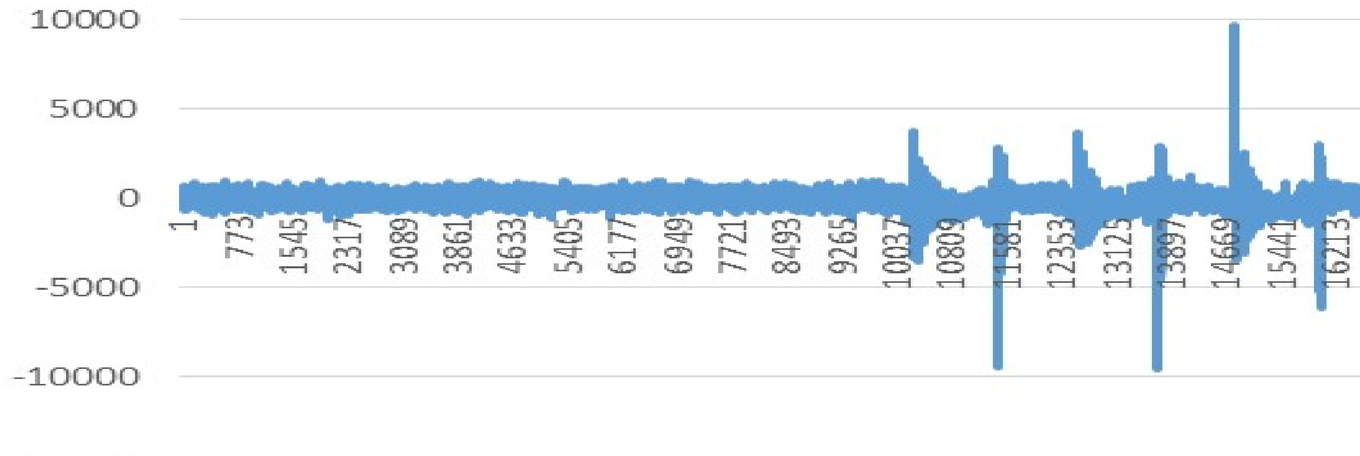
FATIGUE ANALYSIS

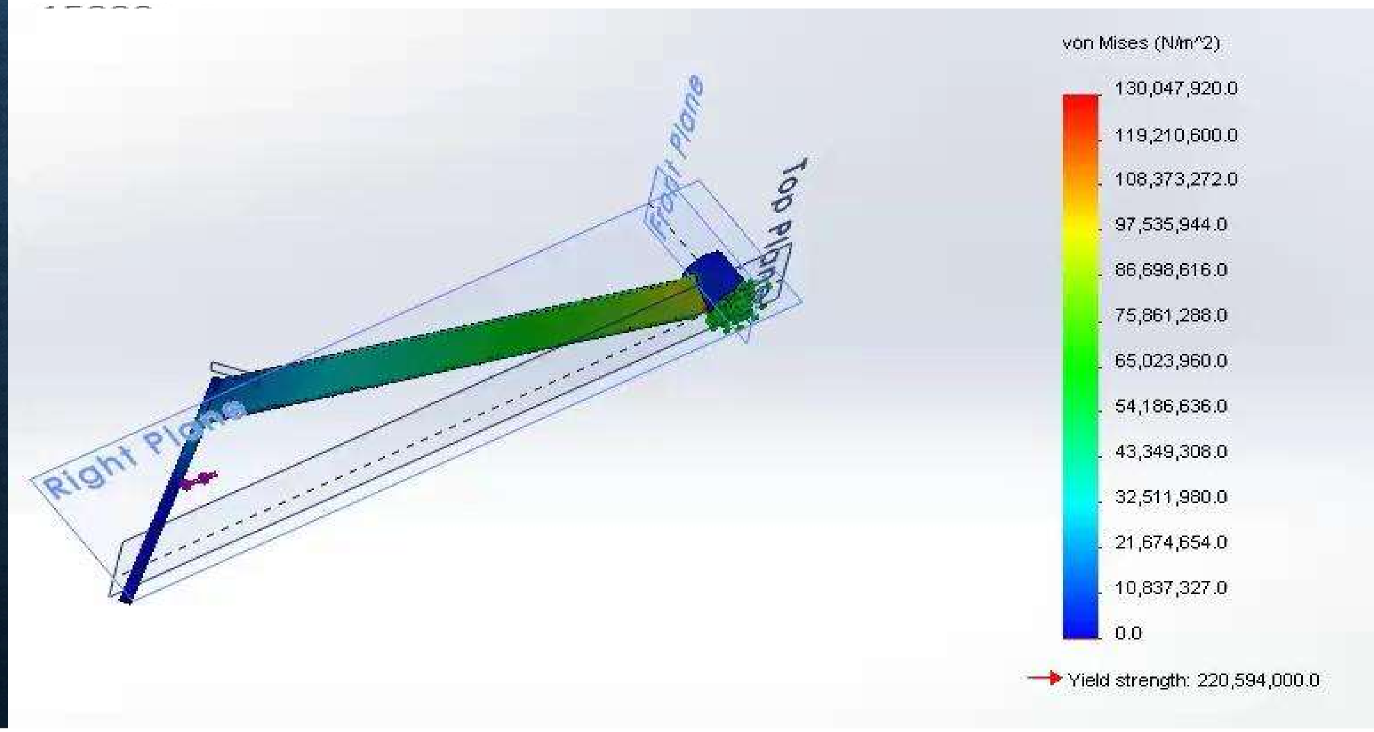
- So all you have to do is install our sensor to collect data.

FATIGUE ANALYSIS

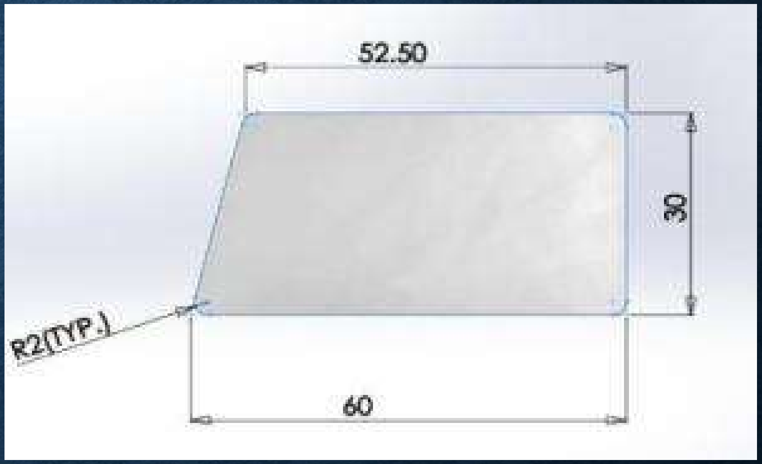
- Conduct a motion test of the mirror.
- You can even see the shock vibration from the video.

- We fed the data into a FEA simulator in Solidworks.
- What we found was a high stress location on the mirror arm (red colour) which corresponded to the welded joint.

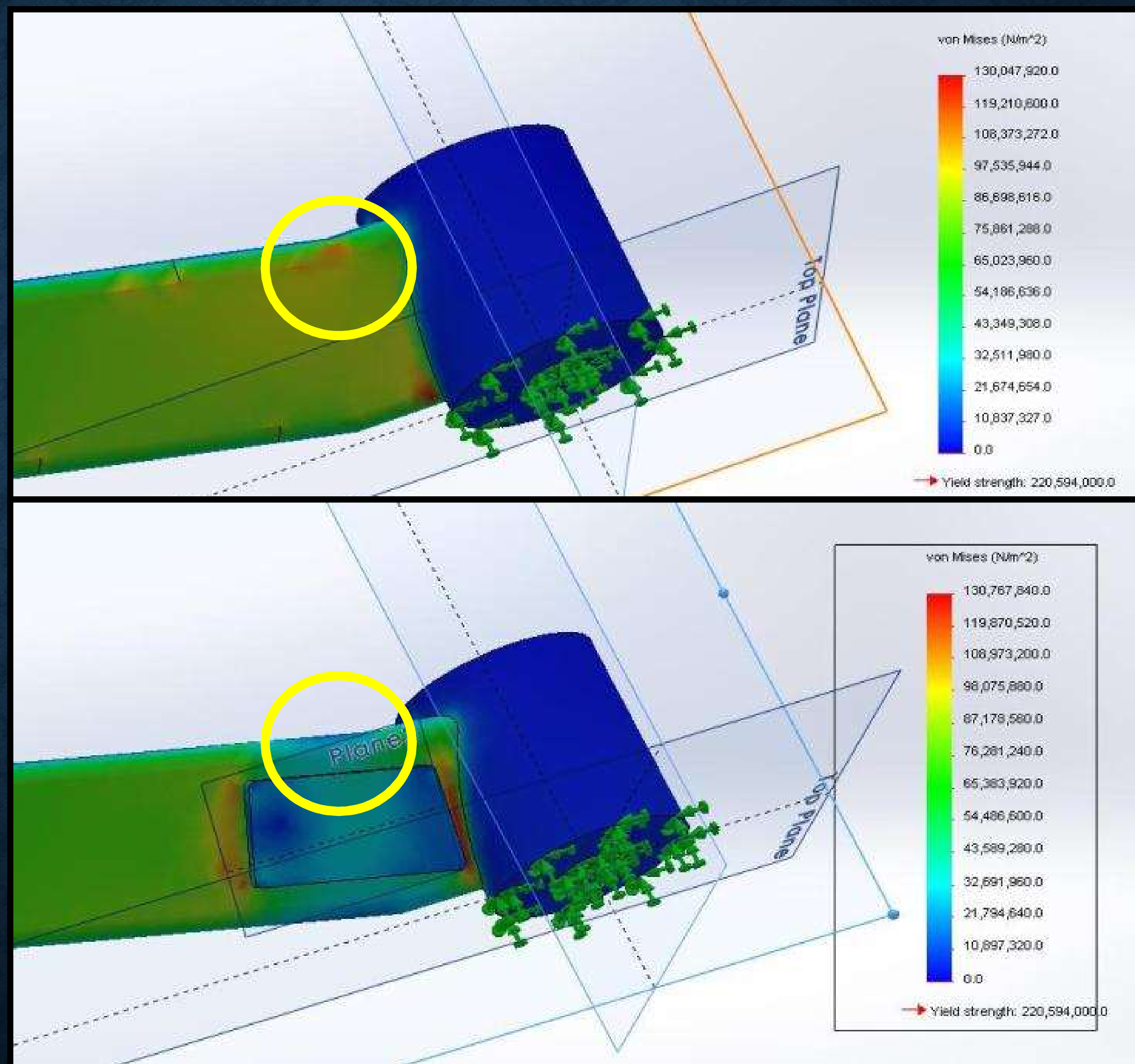




- The solution was we reinforced this area by adding a strengthening plate.



- In order to shift the high stress location away from the weak point at the weld location as you can see from the diagram.



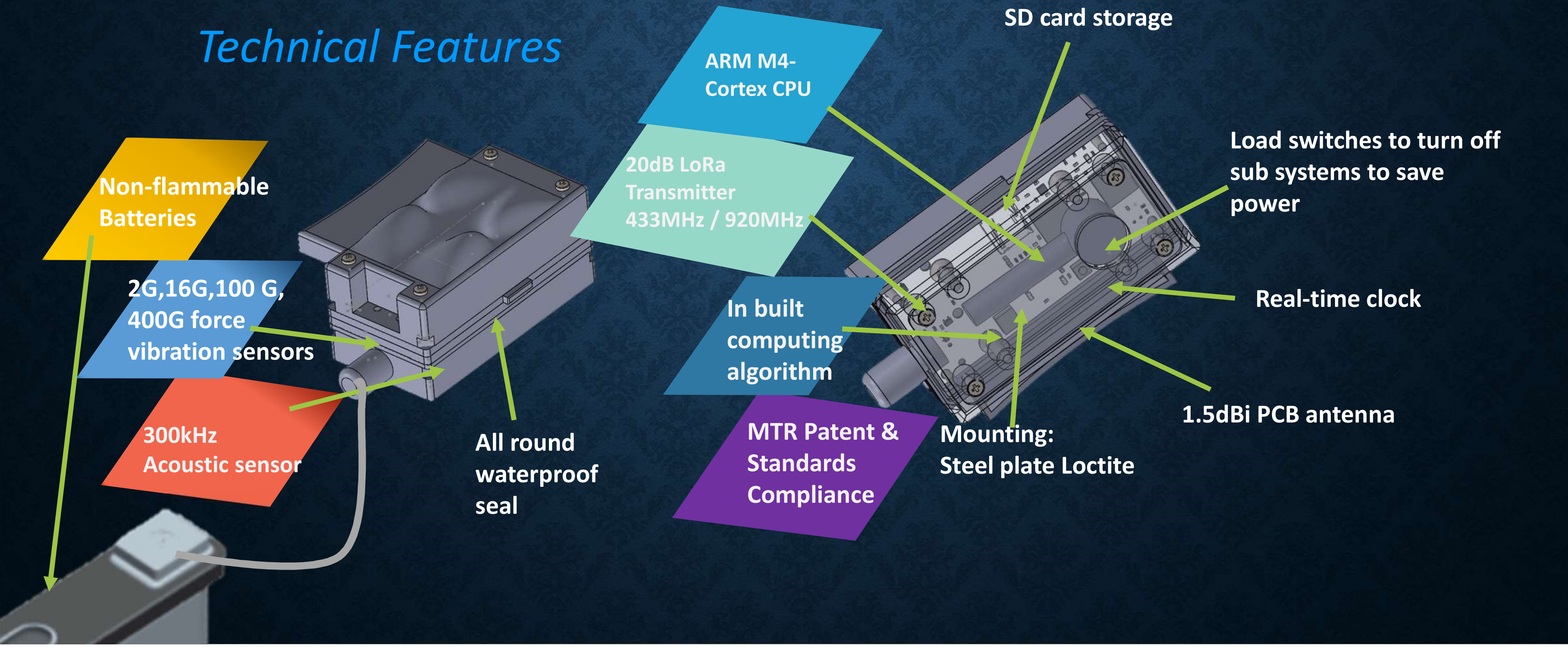
- And this was our reinforcement in real life.

- And we didn't have any problems ever since

UNIQUE DESIGN

1. 1 million hertz sampling frequency for acoustic.
2. 2G to 400G force vibration range sensing at 1000Hz
3. Streaming AI (red, yellow, green).
4. Trend calculation (RMS, peak etc.)
5. Sdcard storage.
6. Long distance transmission.

Technical Features



So I hope I have convinced you that by combining many amazing features into a tiny sensor, make it very user friendly and unleash the power of fusion sensors to the all the layman. Thankyou.