

Maïa Eolis

# INDUSTRIAL CONTEST RESULTS

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 **OROS**  
MEASURING NOISE & VIBRATION



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# Failure Presentation

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MEASURING NOISE & VIBRATION



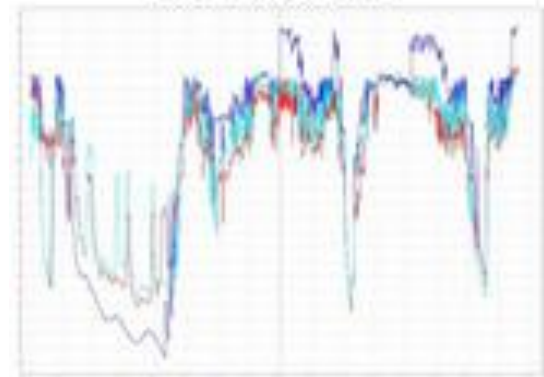
## Wind turbine

- P : 2MW,
- $\eta = 105$  : 3 stage gb
- $\varnothing=82\text{m}$  : 17rpm
- H=80m

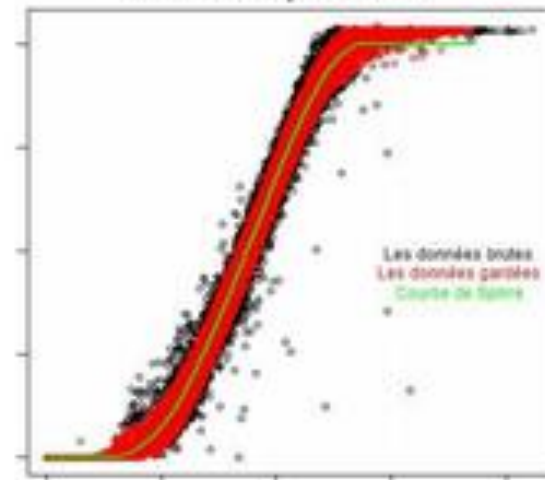
## Condition Monitoring S.

- Vibration & enveloppe a.
- Température
- Oil particule continuous

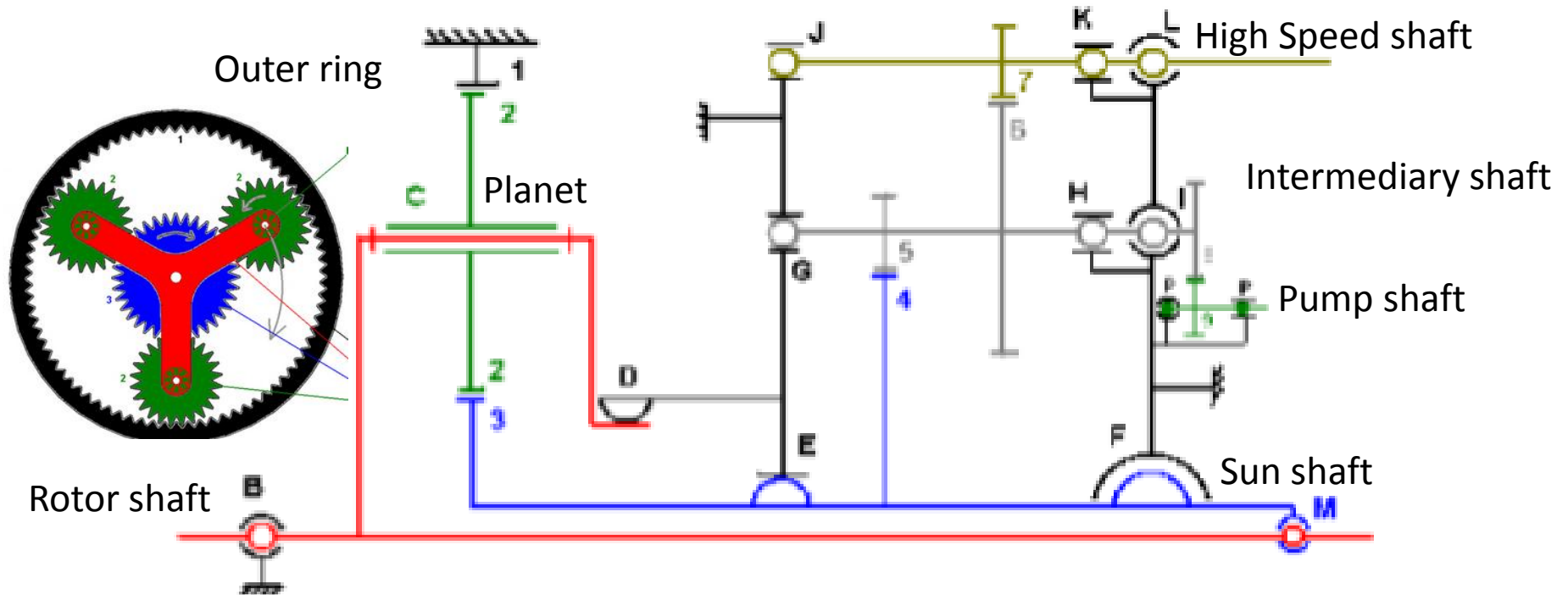
*Suivi Température*



*Courbe de puissance*



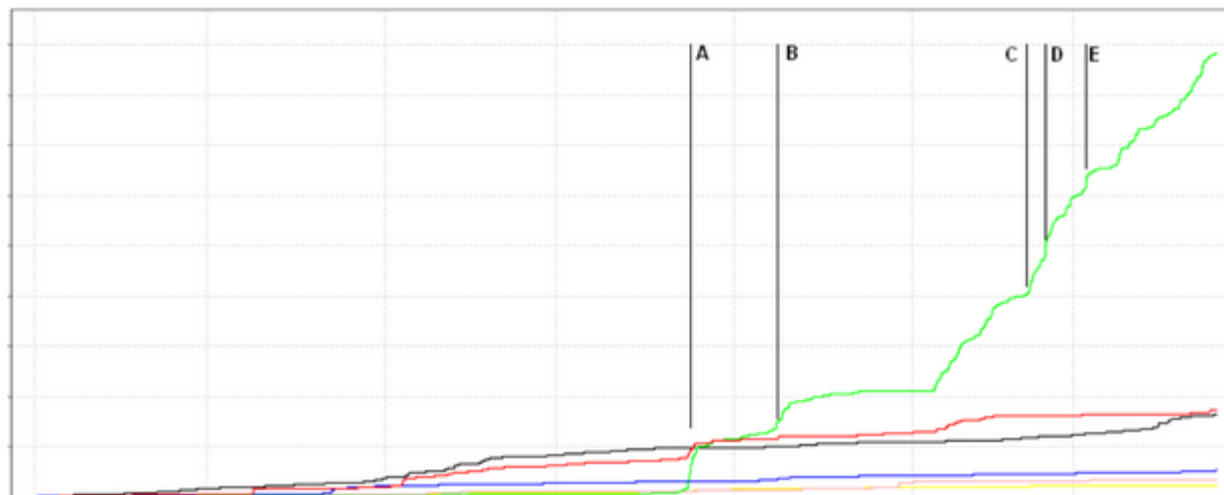
Gearbox presentation:



## History :

- 2010 wind turbine commissioning
- dec 2013 oil particule counting system alarm
- Jan 2014 oil particule stabilization
- feb 2014 video-inspection : fault confirmed and localized
- may 2014 contest vib. measurement
- July 2014 GB replaced

## Particule counting system history

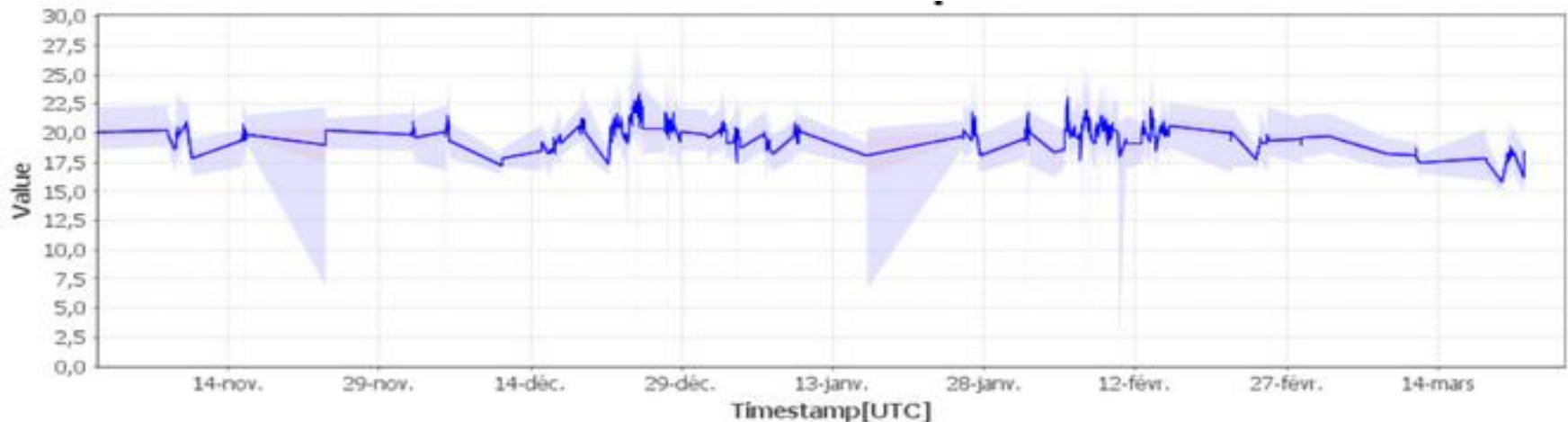


- 25/12/2013 à 08h54 : (A).
- 08/01/2014 à 09h14 : (B).
- 21/02/2014 à 12h29 : (C).
- 24/02/2014 à 03h59 : (D).
- 03/03/2014 à 05h04 : (E).

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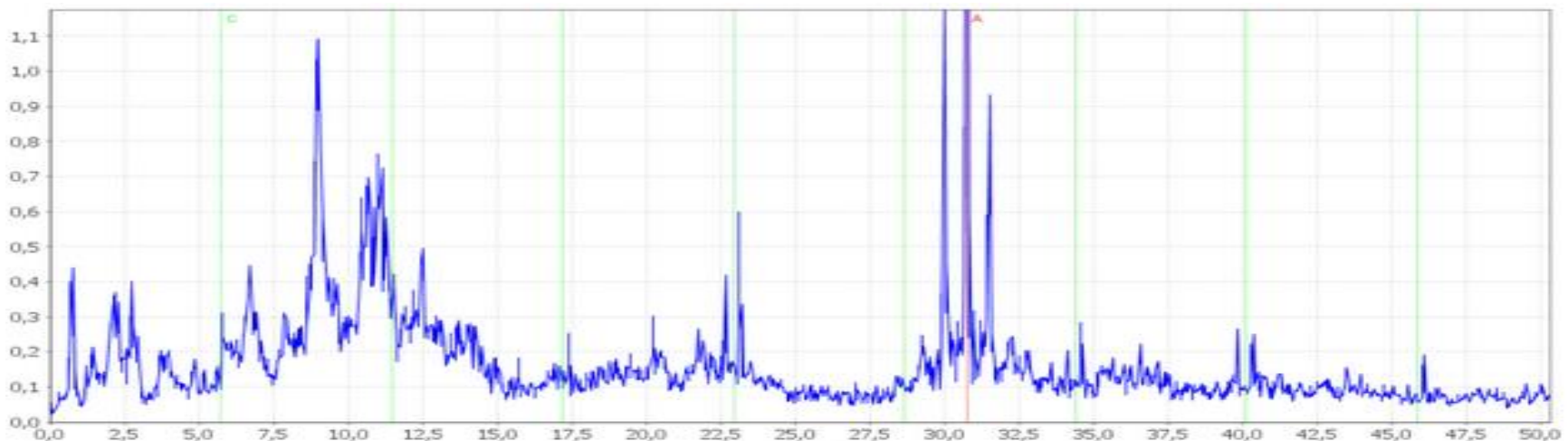
Classical vibration indicator (time domain & spectral envelope) : blind



## History :

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Fault signature visible on long time signal.



## Conclusion :

- Classical Vibration monitoring : OK for HSS
- But LSS bearing fault are low energy
  - Long signal is necessary
  - Order tracking is necessary

## Objective :

- perform order tracking without speed signal.





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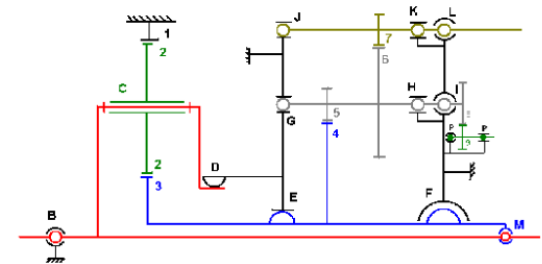


- 23 participants from 13 countries asked for the signal
- ... only 8 analysis reports have been received
- 5 from university, 3 from private companies

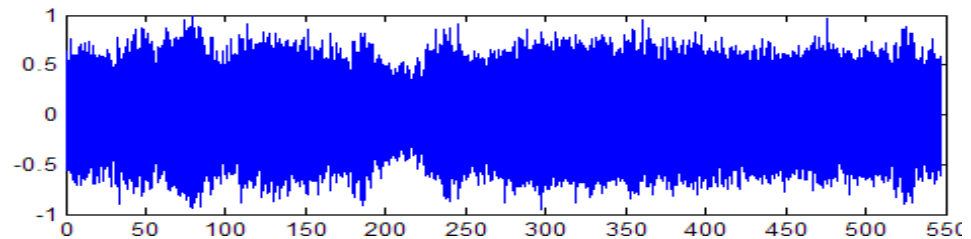
## Provided data :

- Kinematics of the wind turbine gearbox

gear	teeth
1	123
2	50
(3planets)	
3	21
4	93
5	22
6	120
7	29
8	63
9	23
10	10
11	13

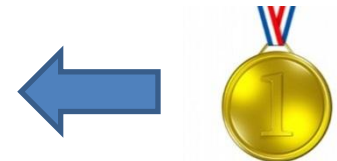


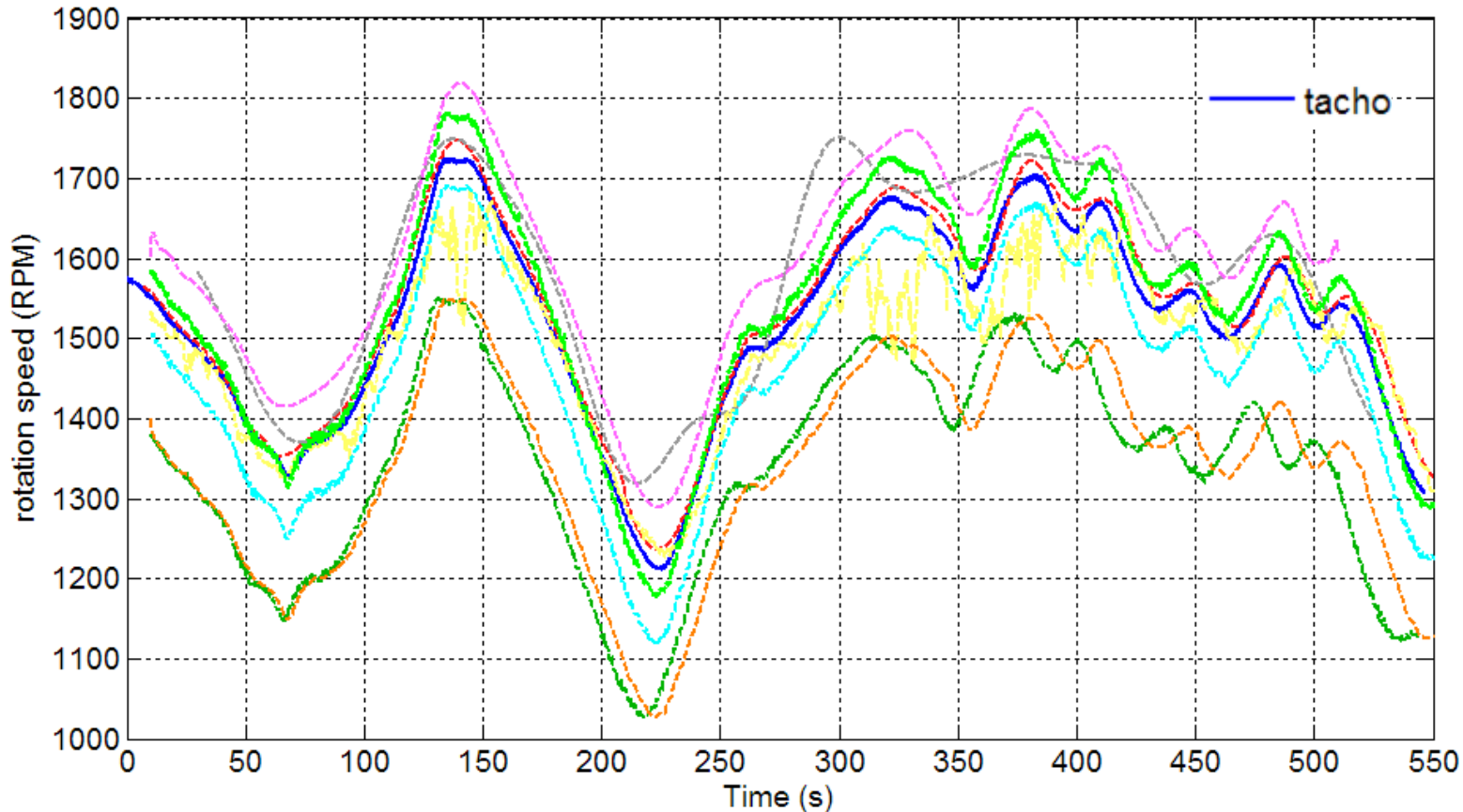
- a vibratory signal measured on the gearbox, about 10 minutes length 5kHz, 8bits



**Objectives :**

- extract the IAS of the high speed shaft
- identify a faulty bearing

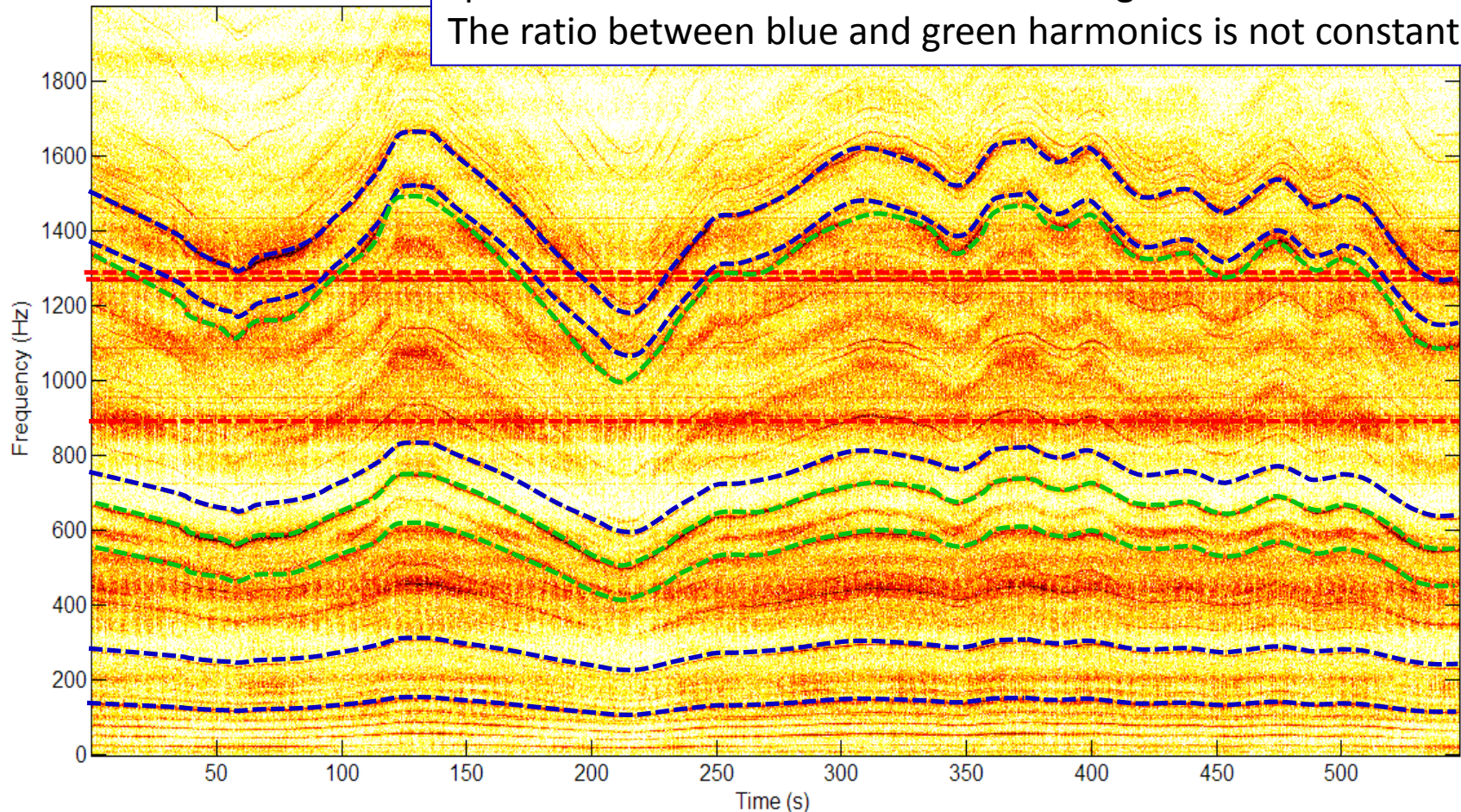




**?** Why so much dispersion in the results ?  
*All participant received exactly the same signal file ...*

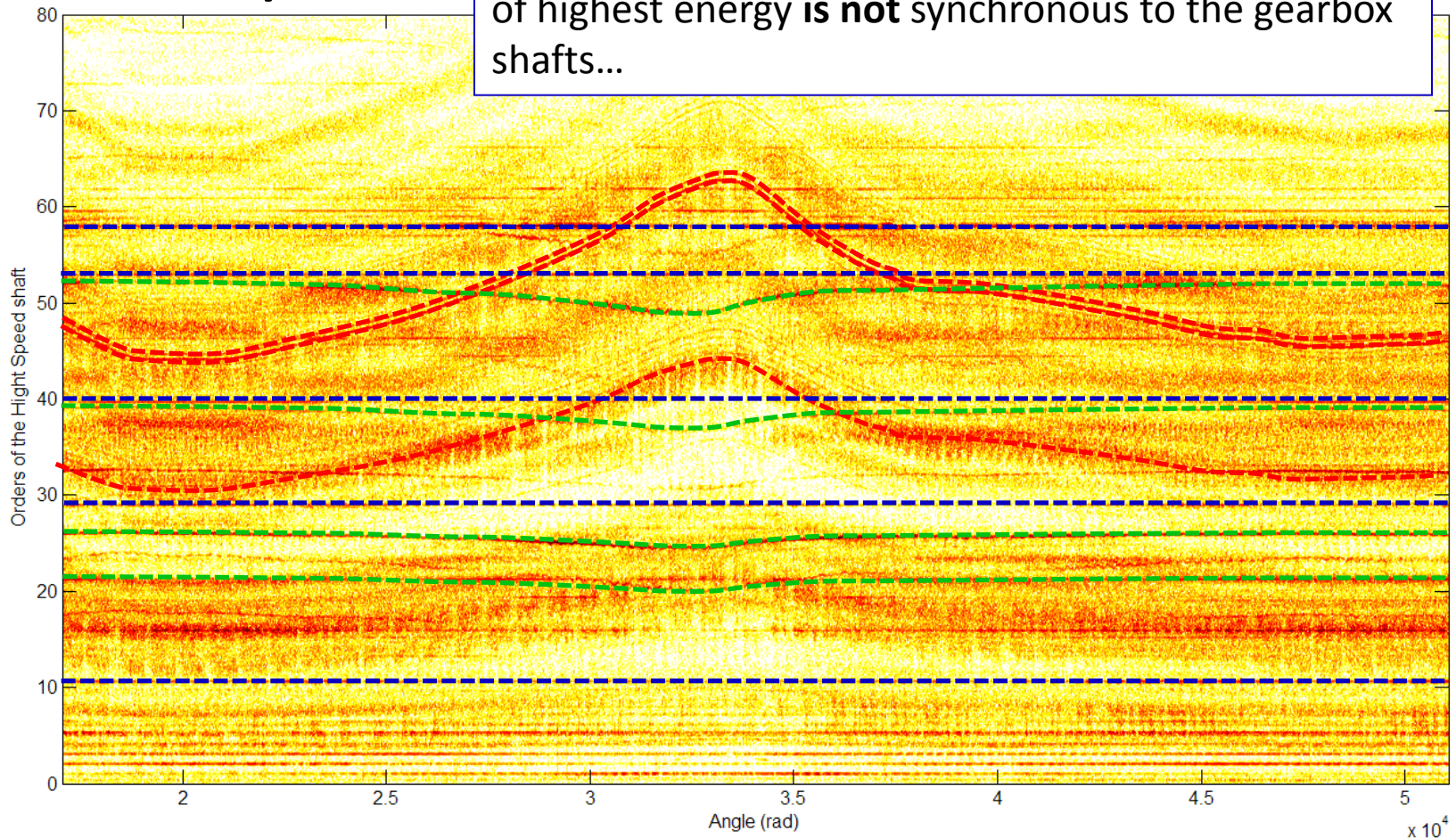
## *Time frequency map*

The blue harmonics are synchronous with the low and high speed shafts. This is not the case of the green ones ...  
The ratio between blue and green harmonics is not constant !



## Angle order map

Unfortunately for half of contestants, the harmonic of highest energy is **not** synchronous to the gearbox shafts...



All contestant had equivalent approaches:

- draw the time frequency map
- Choose a harmonic to track
- Extract the instantaneous frequency (Local maximisation of the TFmap or hilbert transform of the filtered signal)
- **Associate the choosen harmonic to a periodical event (harmonics of the shaft rotation / gear meshing)**
- Deduce the instantaneous speed

A final step is often neglected:

- Check that the extracted IAS is coherent with other harmonics in the signal !

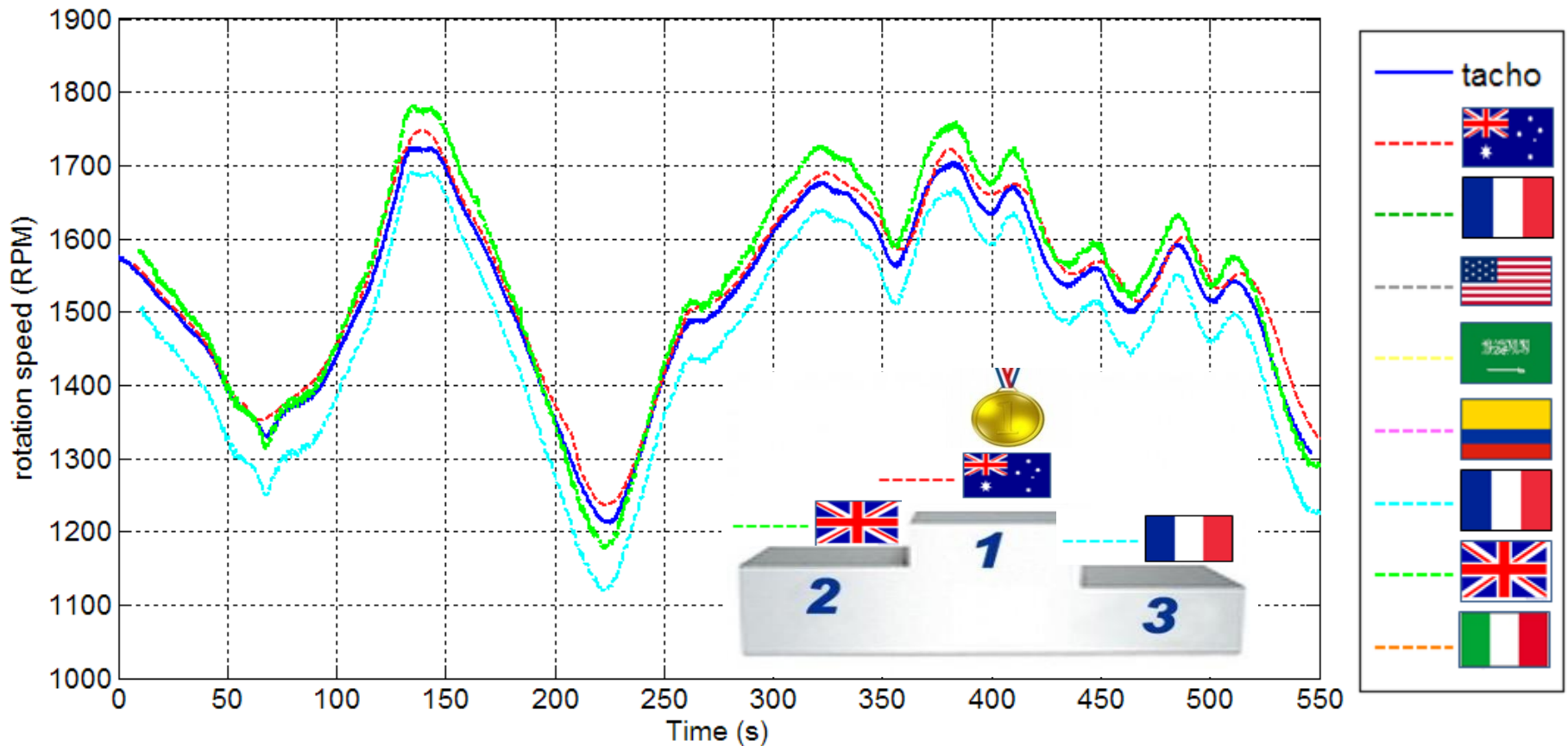


**Critical !**





## The podium



***Congratulations to the winning team !***



Robert B Randall, Michael D  
Coats, Wade A. Smith  
University of New South Wales,  
Sydney, NSW 2052, Australia



Congratulation to 2<sup>nd</sup> and 3<sup>rd</sup> teams

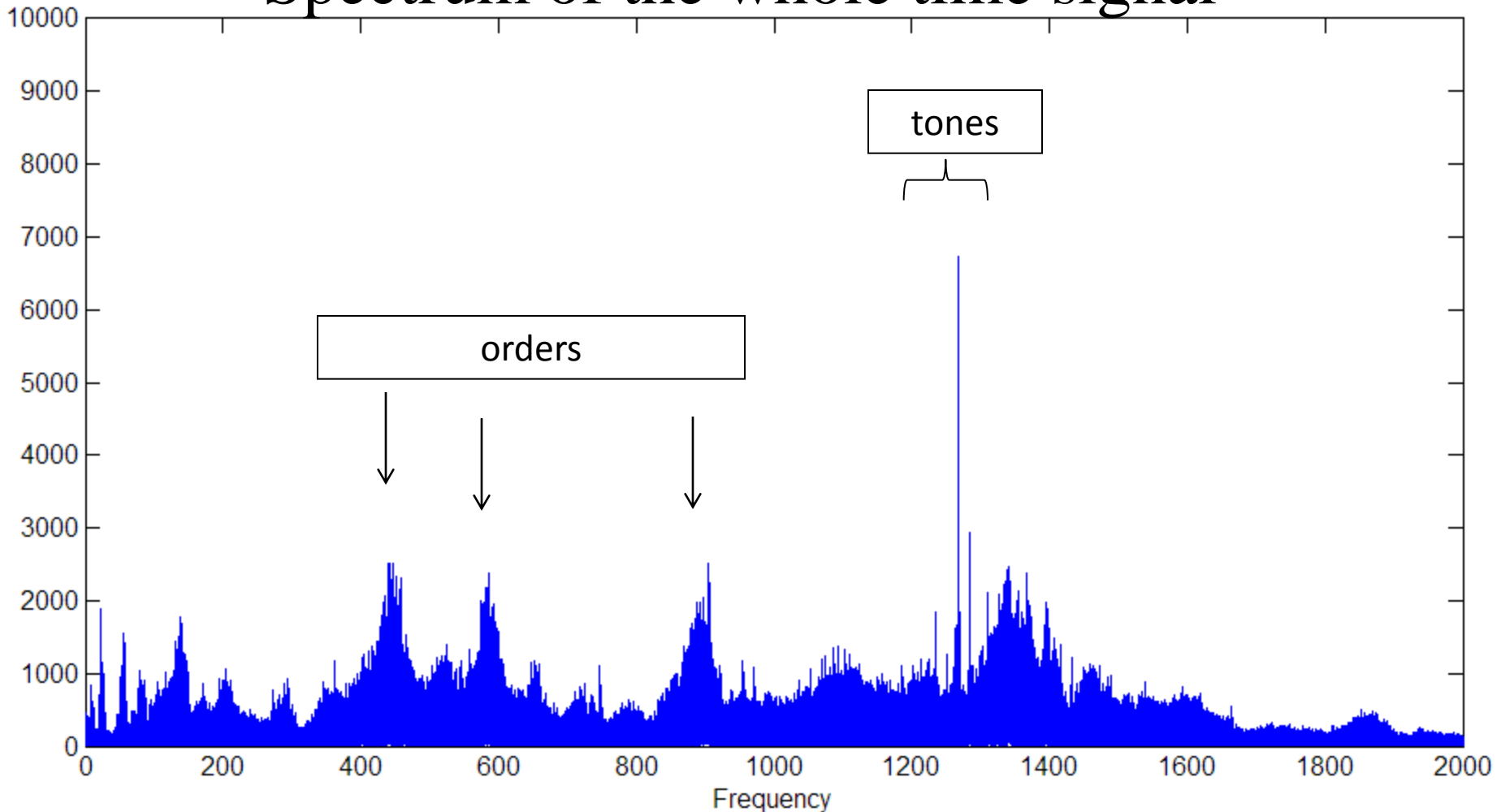
Second place : **Dyson**, UK, L. Desvard and Ben Mercer

Third place : **SAIGA team at GIPSA-lab**, Fr, Pascal Bellemain,  
Marcin Firla, Timothée Gerber, Zhong-Yang Li, and Nadine Martin

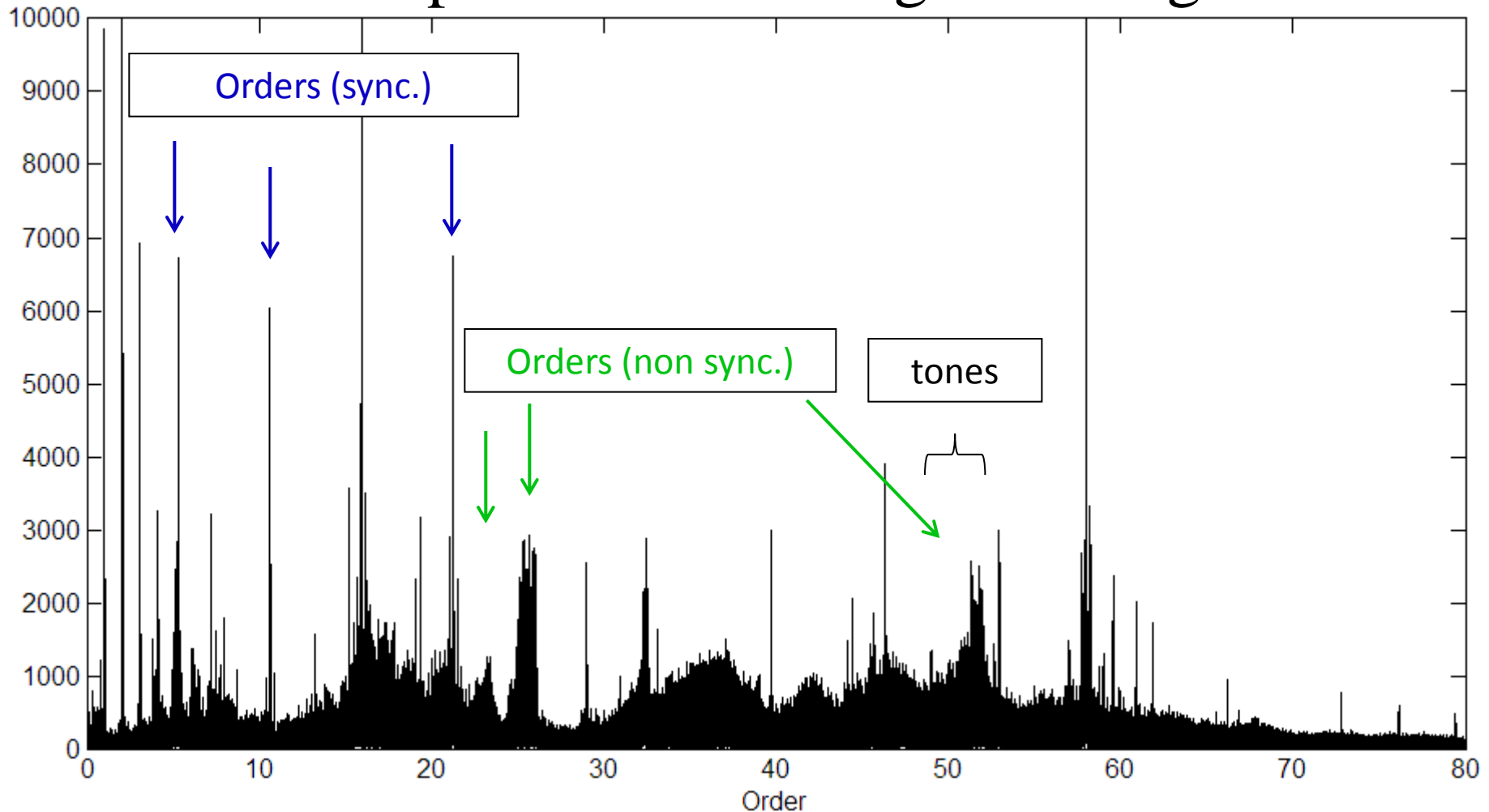
**And many thanks to all participants**

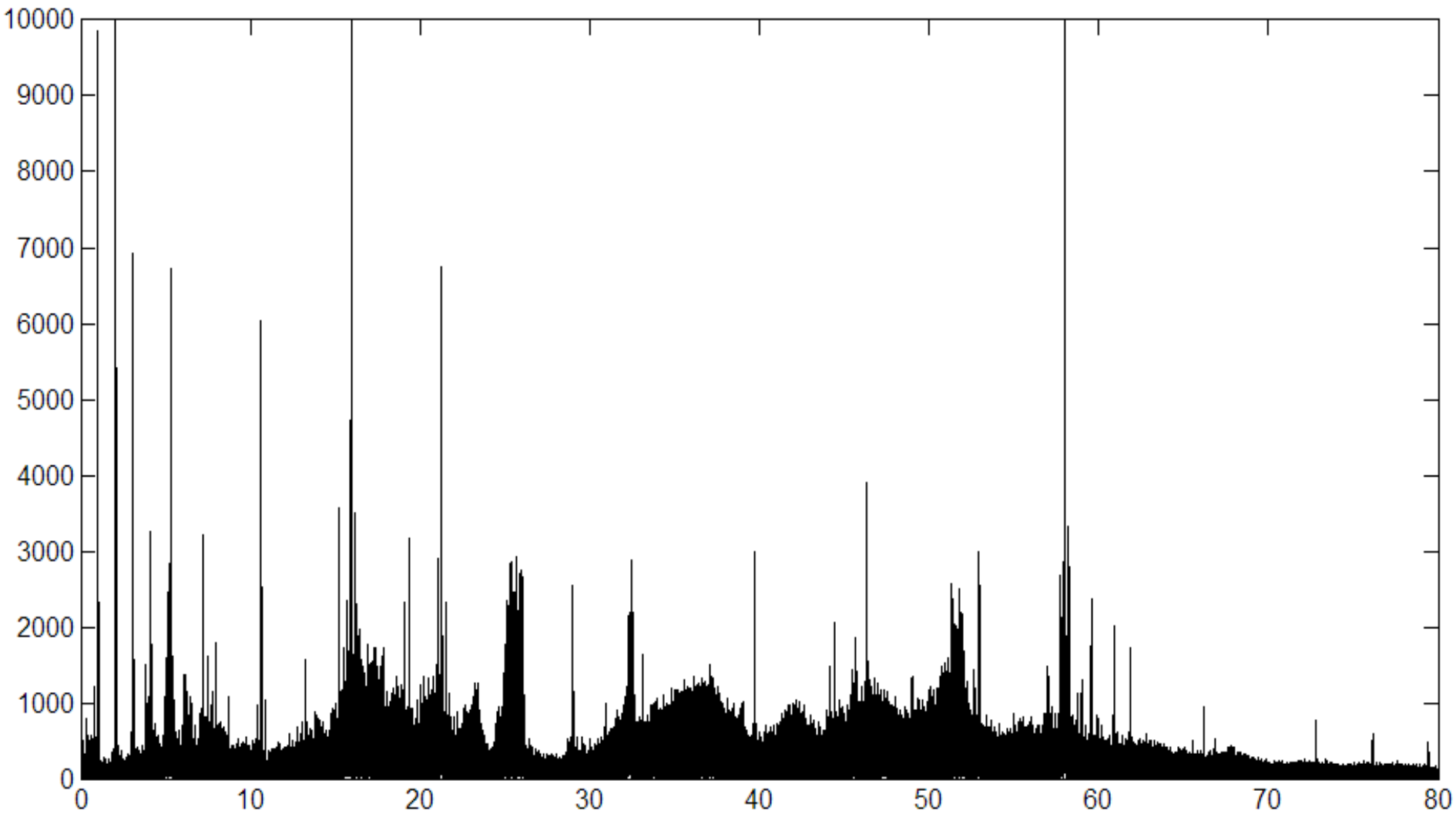
Failure identification ...

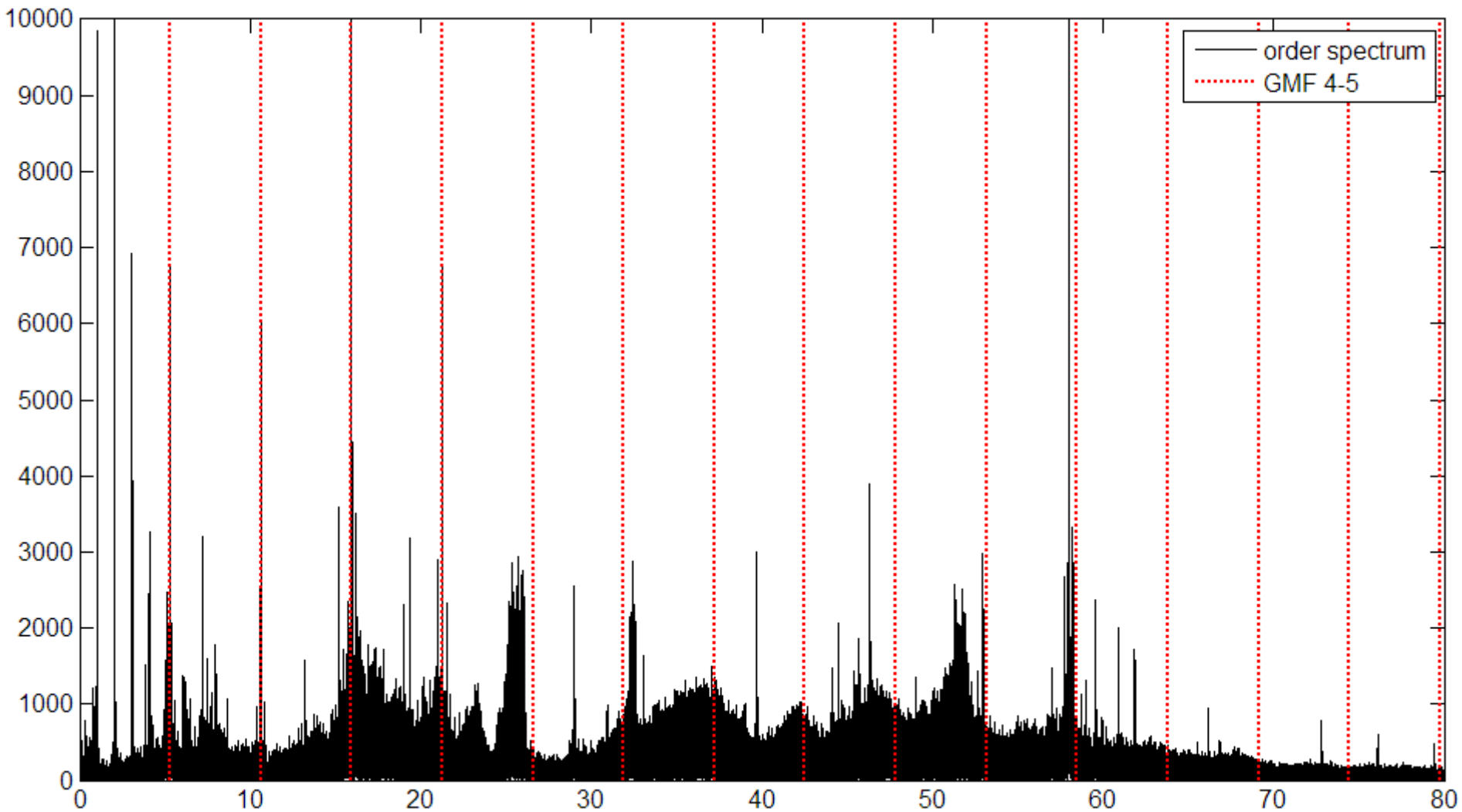
## Spectrum of the whole time signal

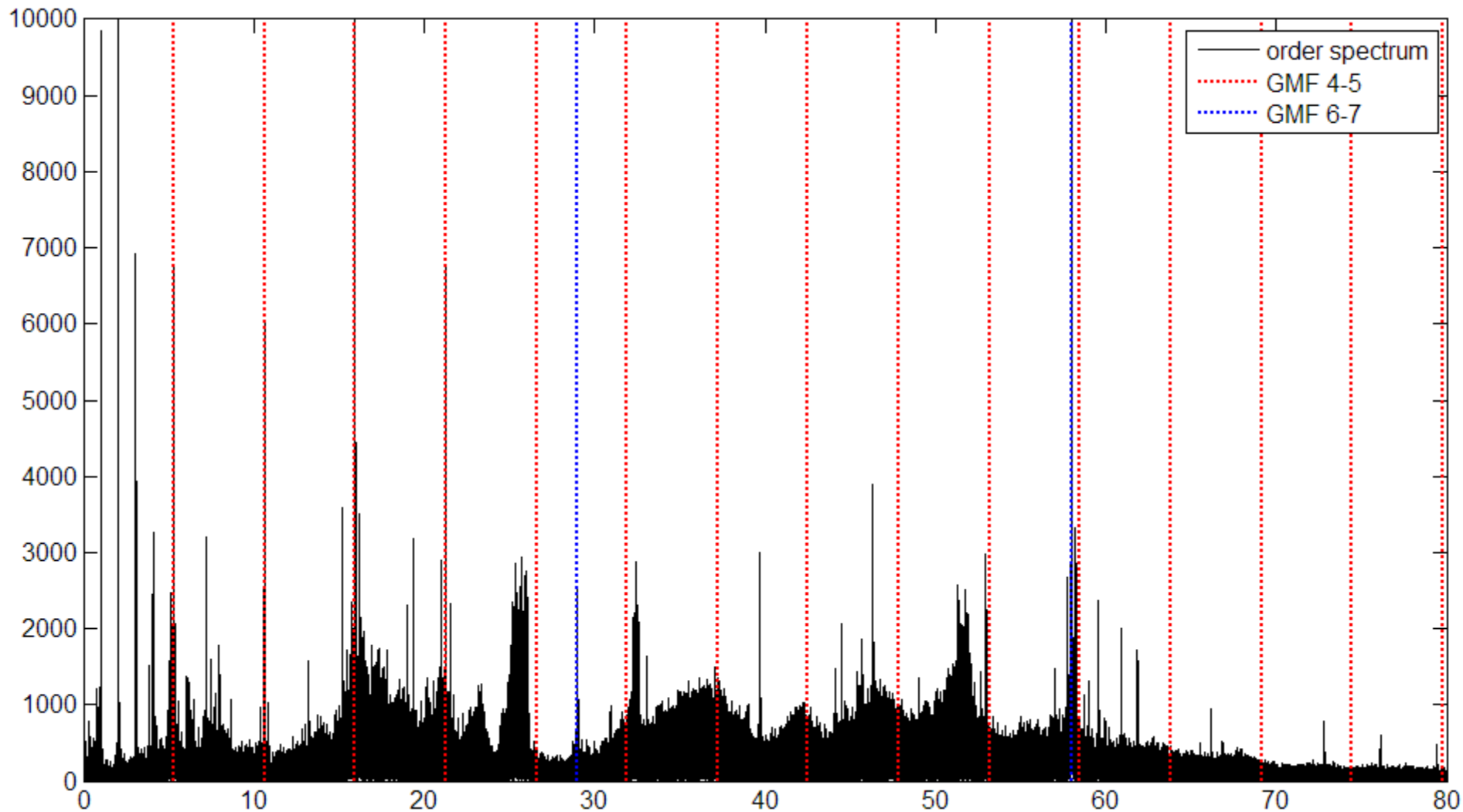


## Order spectrum of the signal in angle

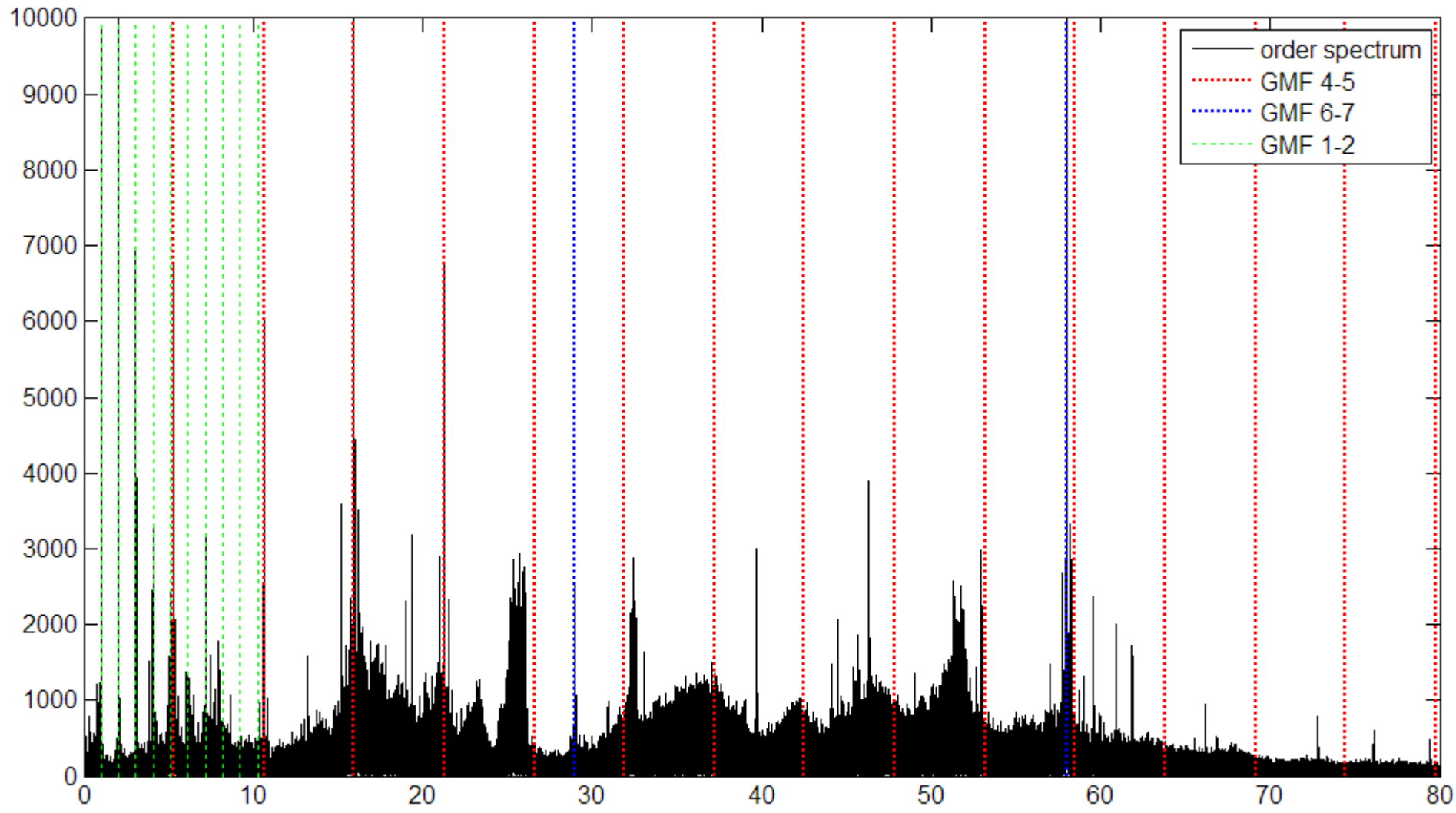


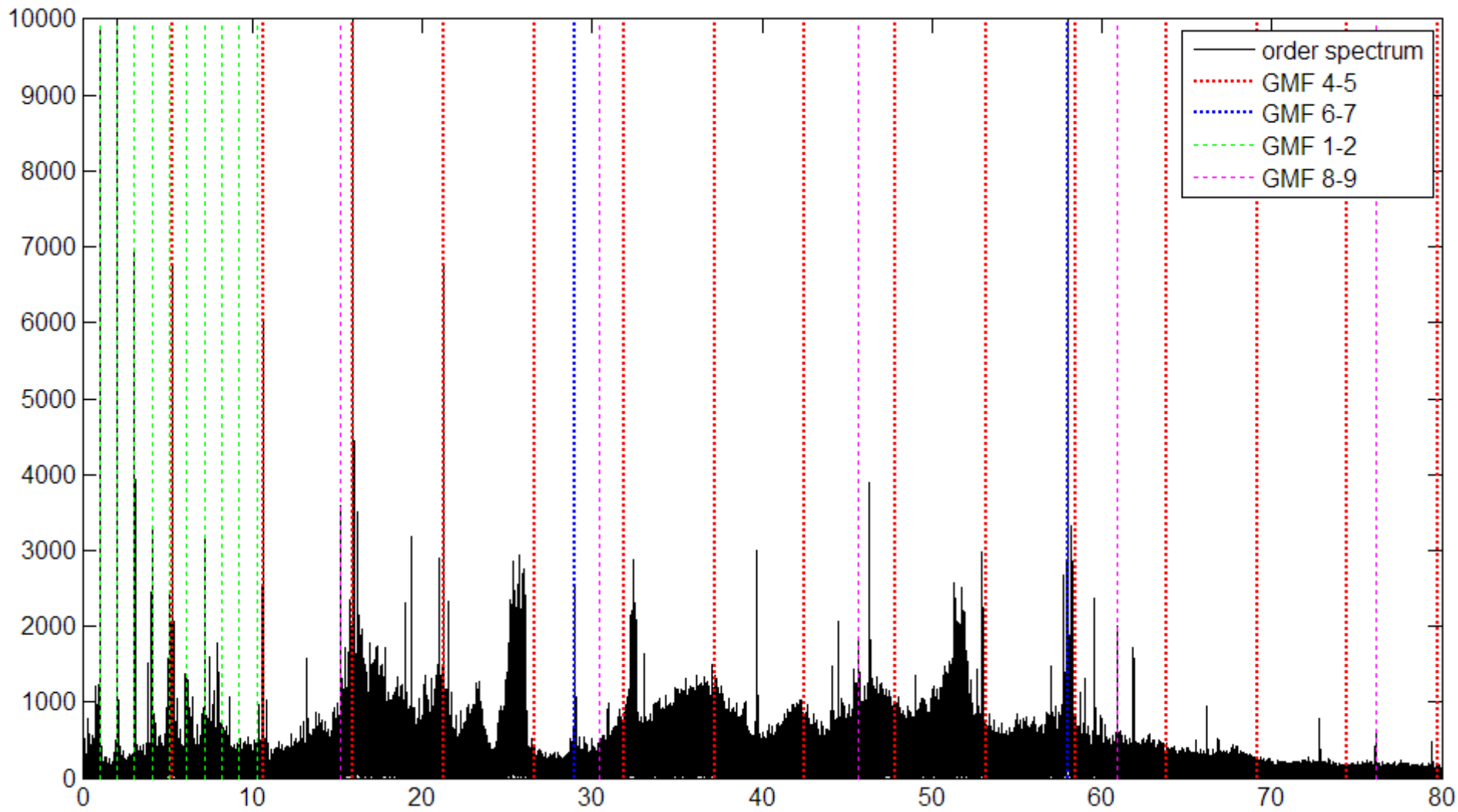


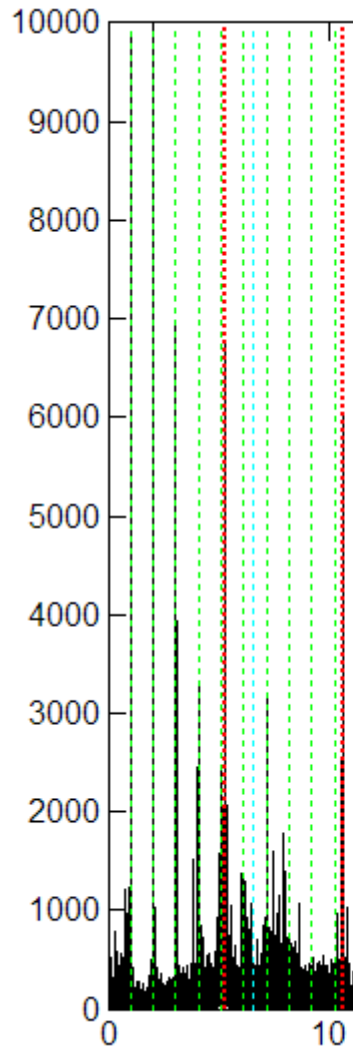




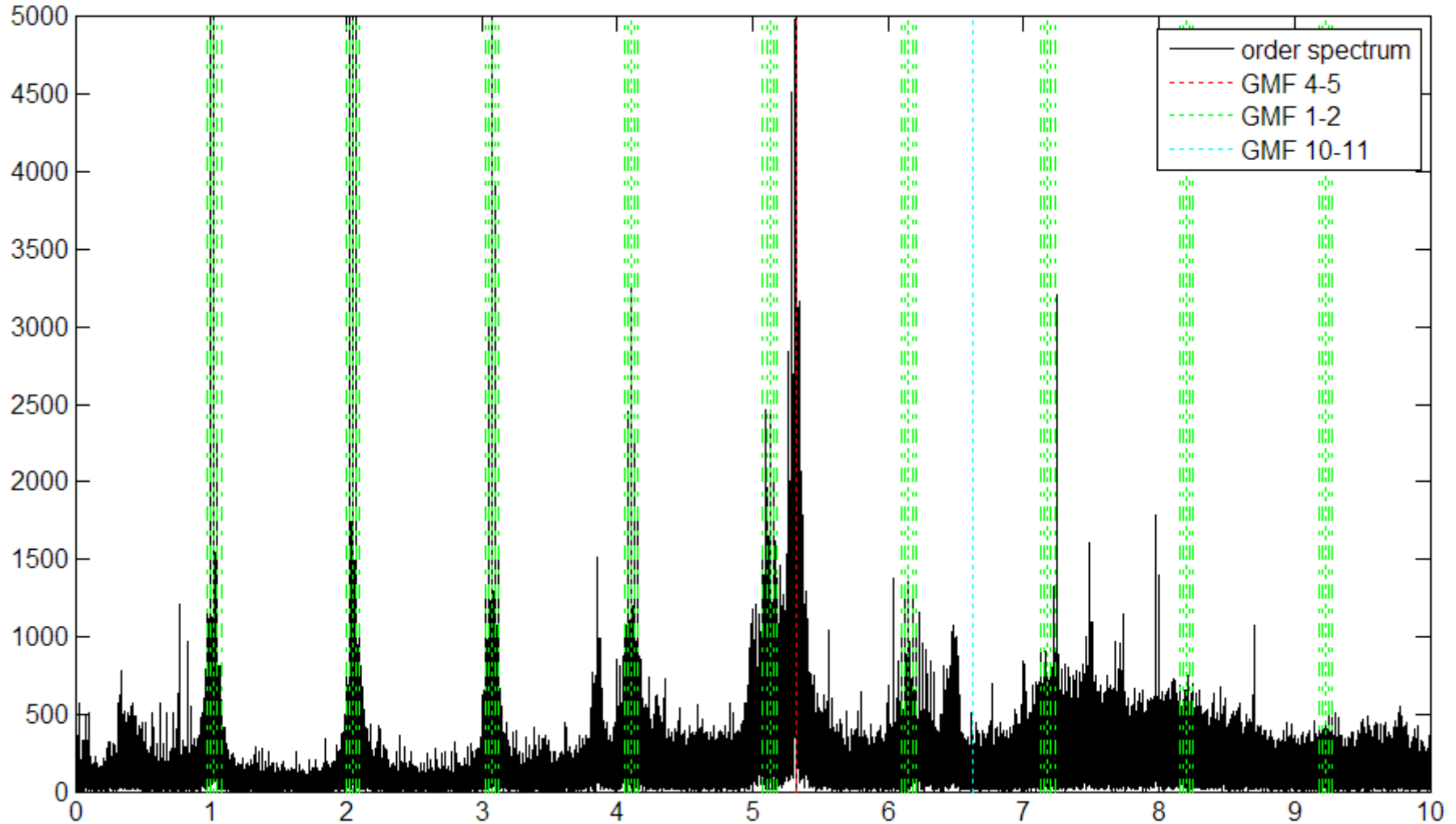


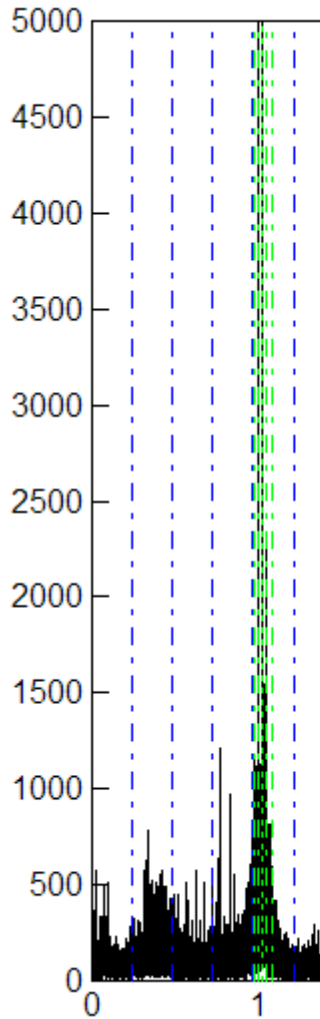






Focus on the low order spectrum :  
[0 10] x High speed shaft





Focus on the very low order spectrum :  
[0 1.5] x High speed shaft

