



# Title: Descomposición en modos empíricos y su aplicación en la detección de fallas en rodamientos

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**Editorial label ECORFAN:** 607-8534  
**BCIERMMI Control Number:** 2018-03  
**BCIERMMI Classification (2018):** 251018-0301

**Pages:** 28  
**RNA:** 03-2010-032610115700-14

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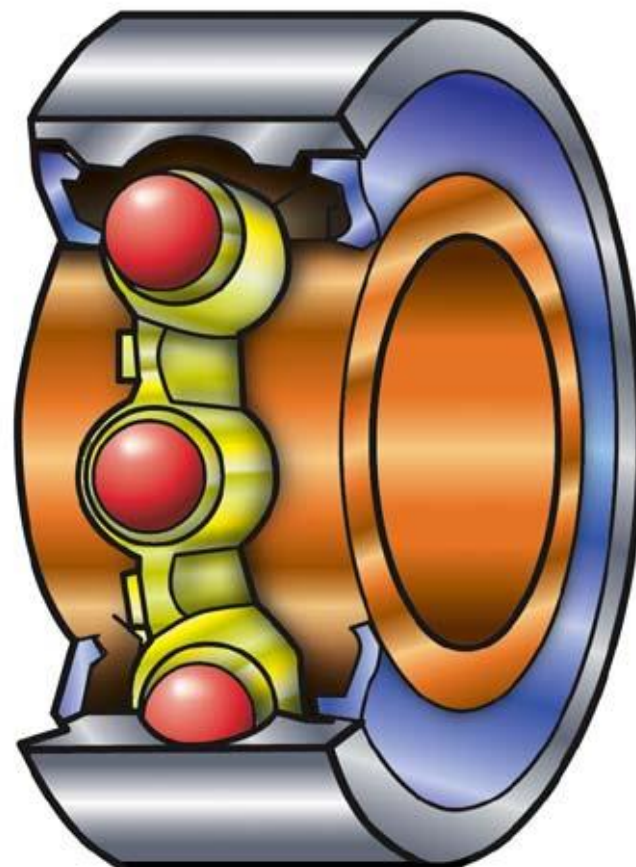
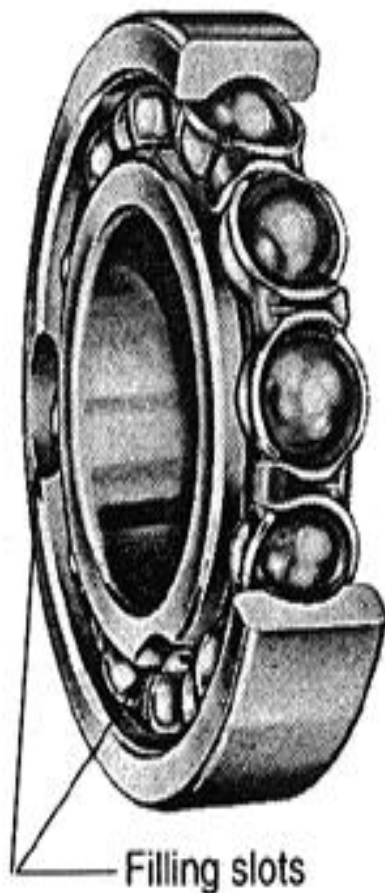
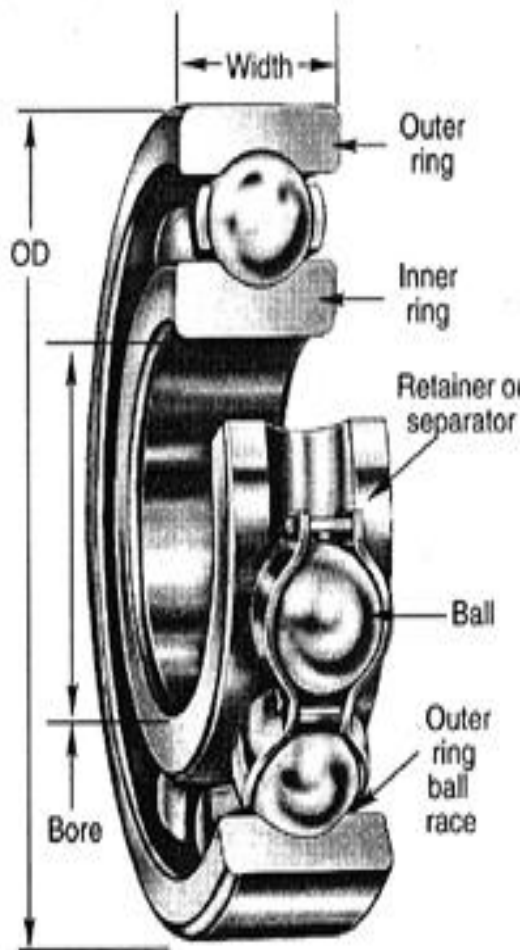
# Introducción

- Los costos de mantenimiento son una parte significativa de los gastos totales
  - Importancia del monitoreo de condición
- Una parte de los costos de mantenimiento es inútilmente desperdiciada
  - Mantenimiento innecesario
  - Mantenimiento inadecuado realizado
- Monitoreo de condición con el diagnóstico adecuado permite el mantenimiento en función del estado actual

# Rodamientos

- Un rodamiento es un dispositivo que proporciona soporte entre al menos 2 superficies, generalmente 1 estática y la otra dinámica.
- Ampliamente usados en motores eléctricos, cajas de engranes, vehículos, etc.

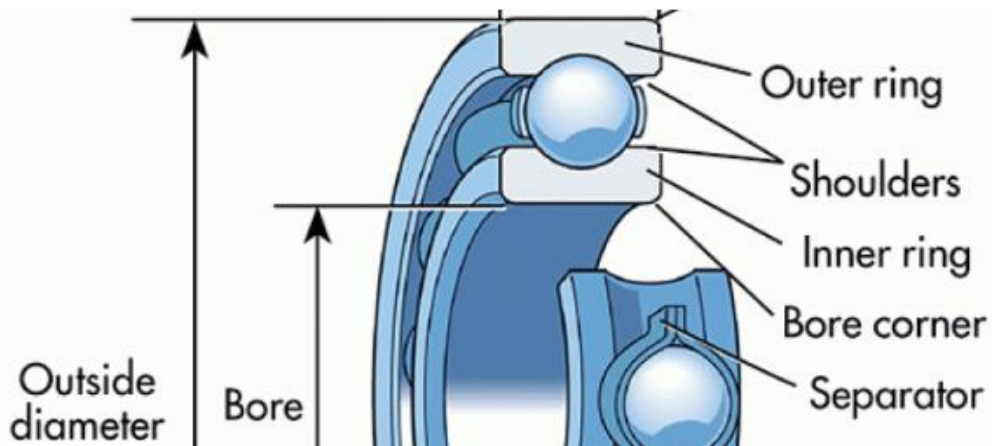
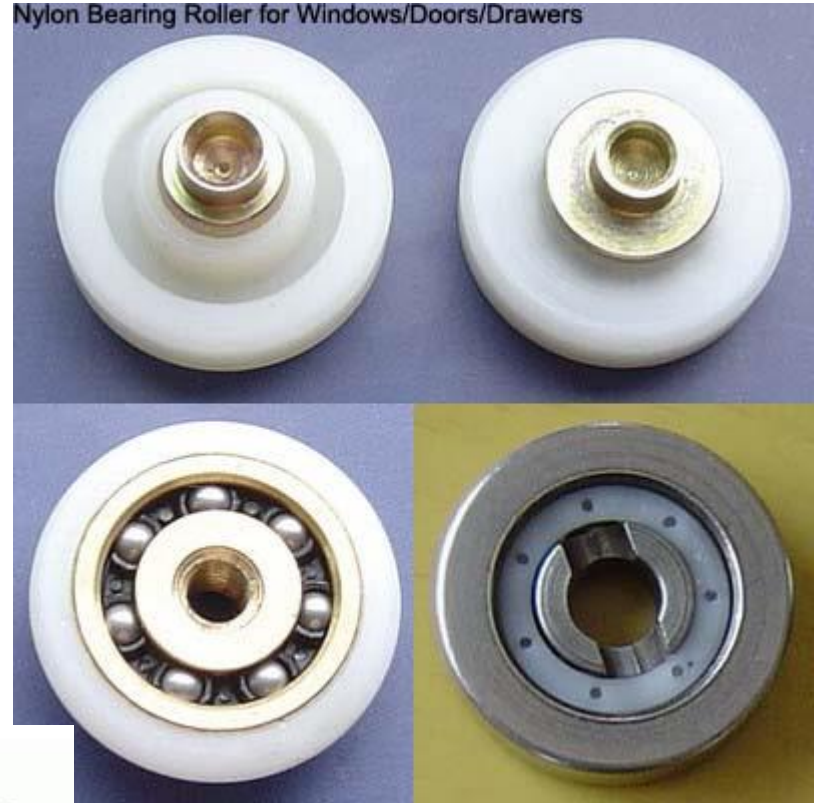
# Rodamientos



# Rodamientos



Nylon Bearing Roller for Windows/Doors/Drawers



# Rodamientos

- Defectos en la pista interna

$$f_{ir} = \frac{n}{2} f_r \left( 1 + \frac{d}{D} \cos \alpha \right) \quad (1)$$










Defectos en la pista externa

$$f_{or} = \frac{n}{2} f_r \left( 1 - \frac{d}{D} \cos \alpha \right) \quad (2)$$



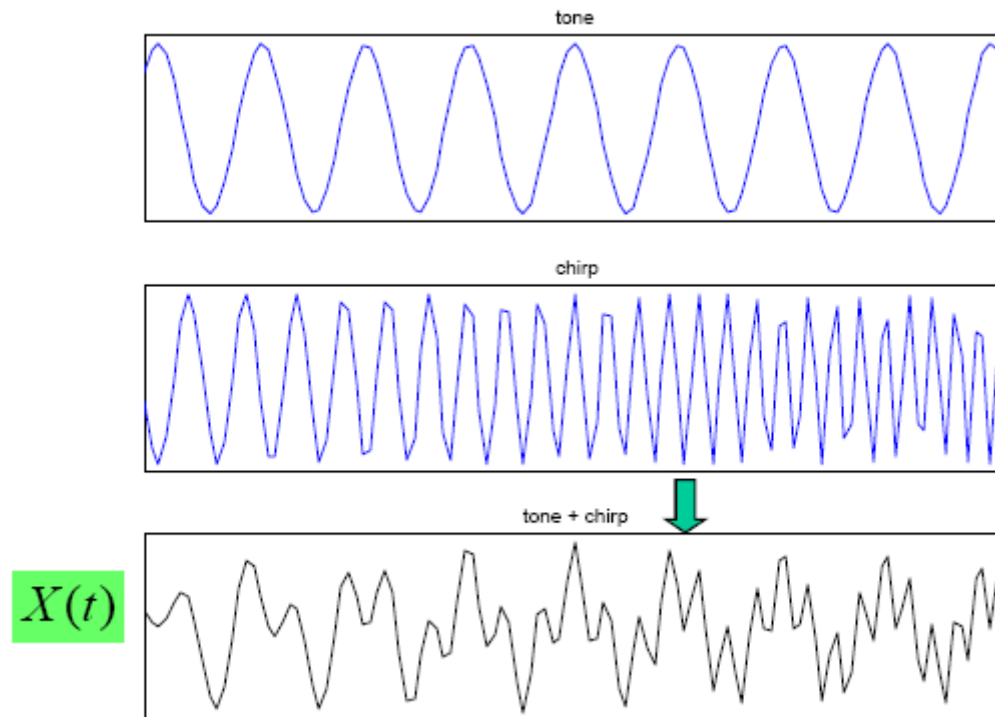
- Método para procesar señales no estacionarias y señales producidas por procesos no lineales
- Se descompone la señal en un conjunto de funciones de modo intrínseco

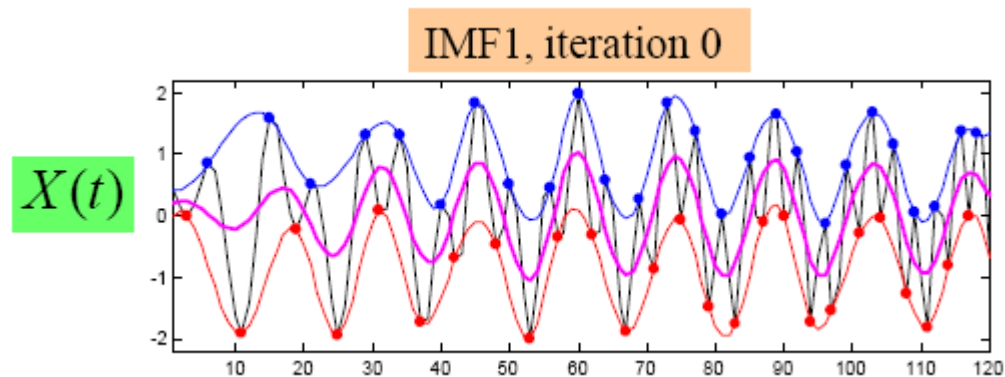
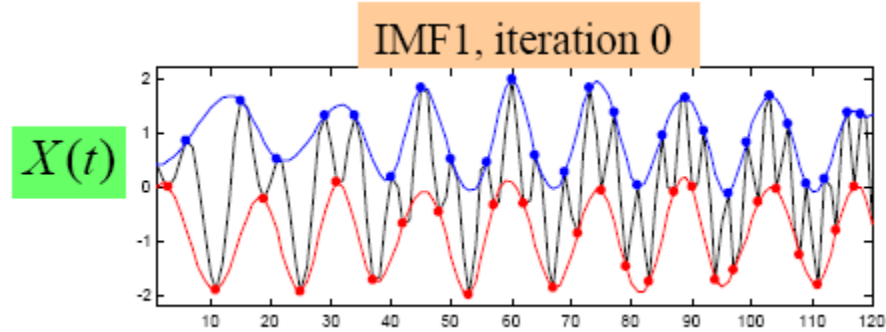
# Técnicas de análisis tiempo-frecuencia

	FFT	Wavelet	EMD
¿A priori?	<i>Si</i>	<i>Si</i>	Adaptivo
No lineales			
No estacionario			
Extracción de características			

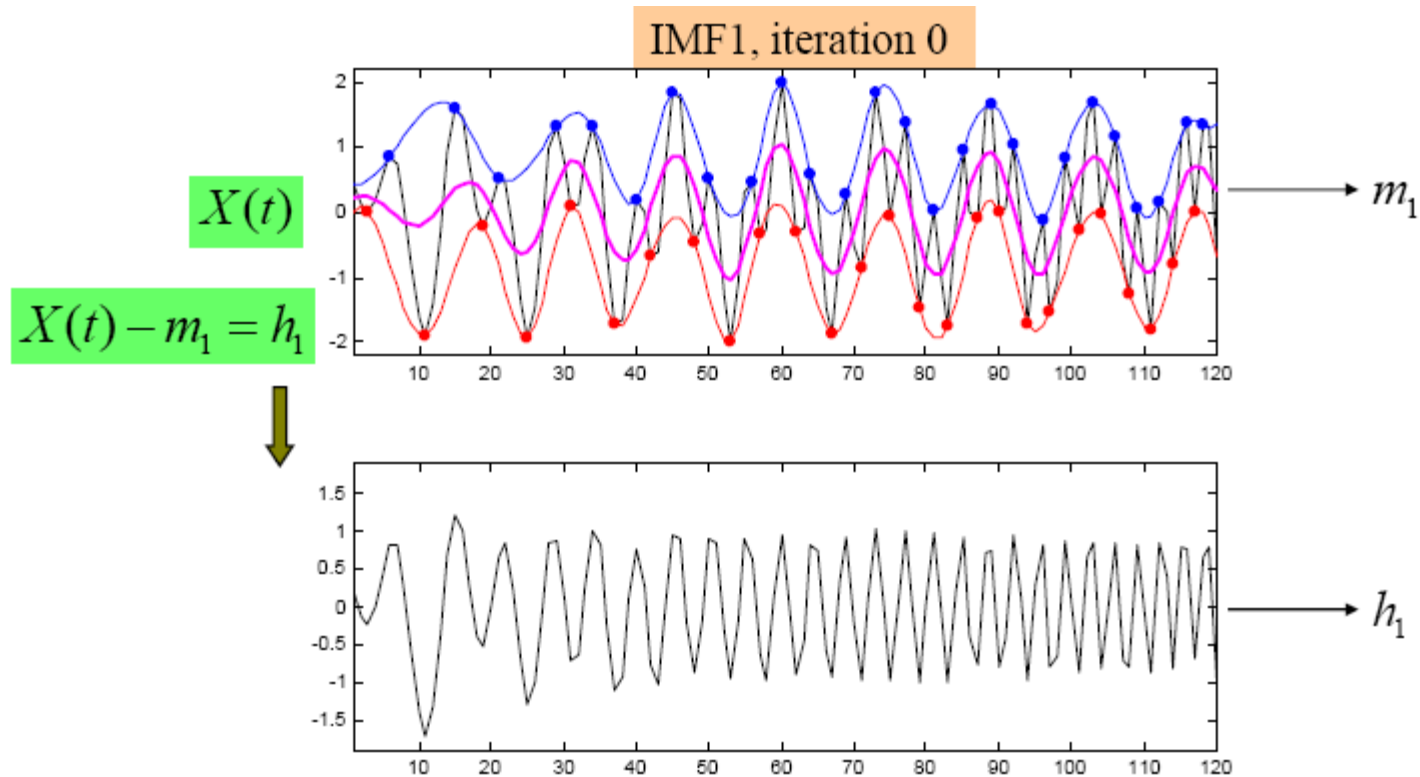


# Ejemplo

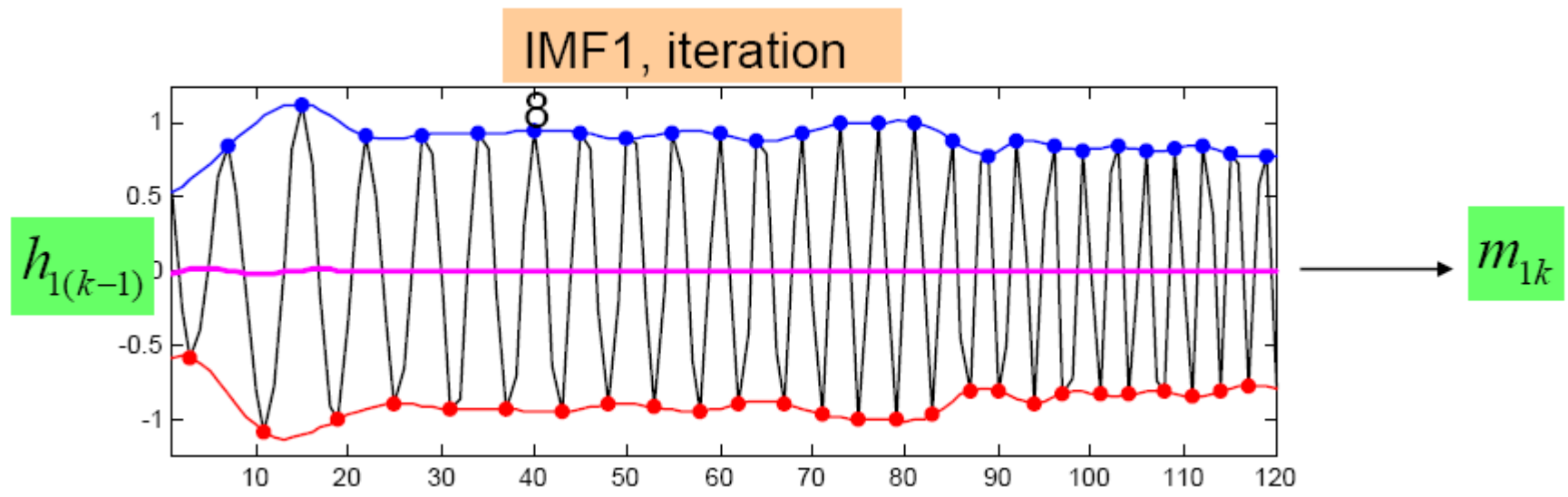




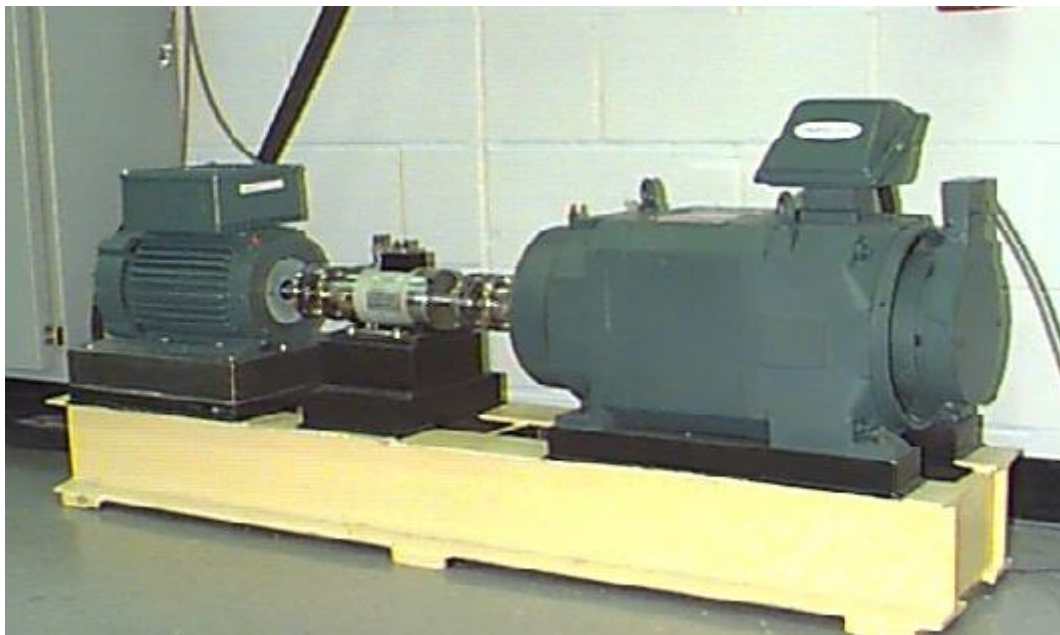
# Ejemplo



# Ejemplo

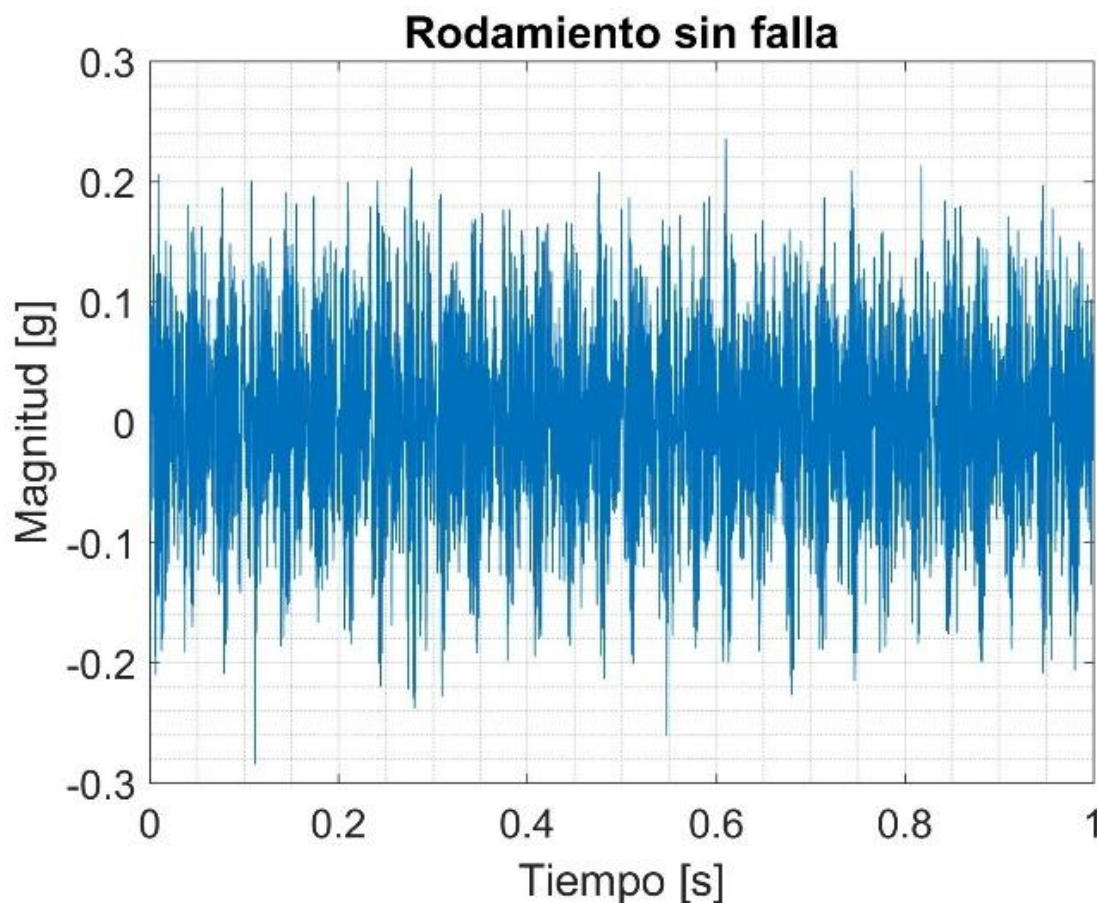


# Plataforma experimental

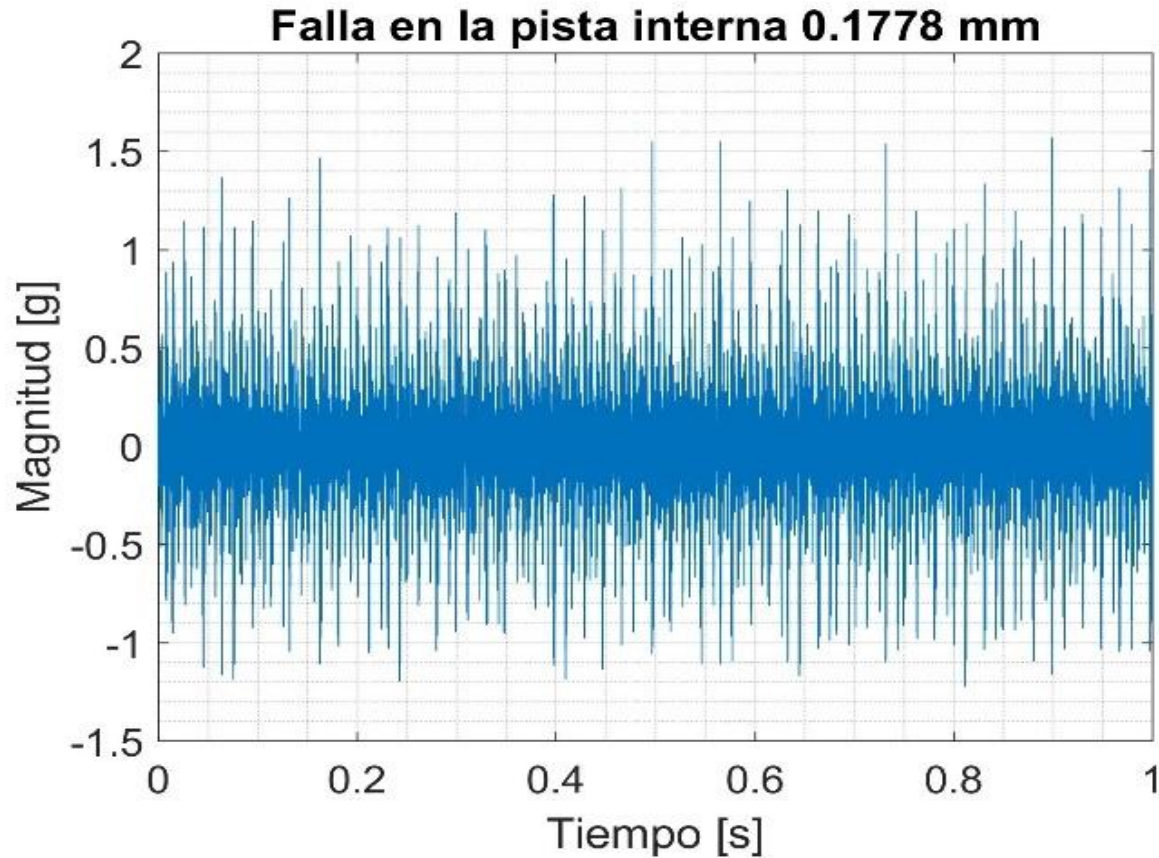


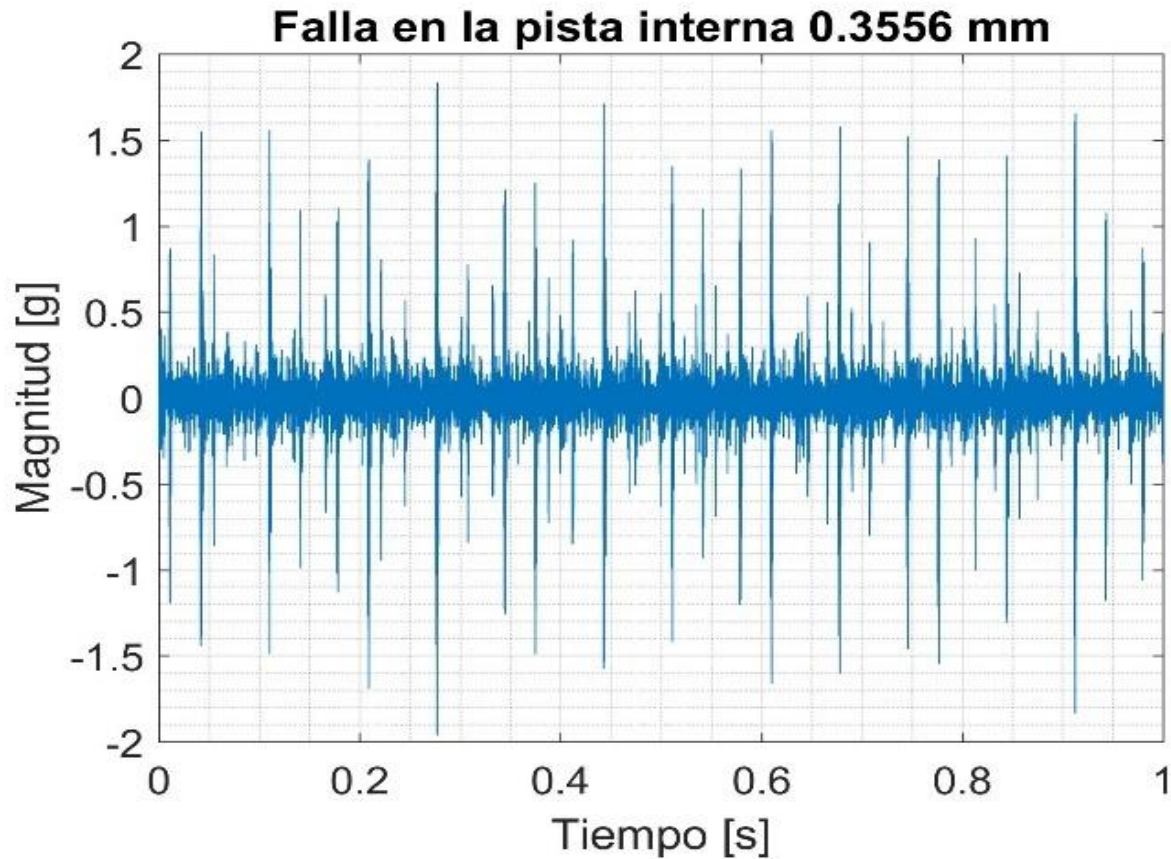
- Frecuencia de muestreo 12 KHz
- Velocidad 1797 RPM,  $f_r=29.95\text{Hz}$
- 3 severidades de falla 0.1778 mm, 0.3556 mm y 0.5334 mm

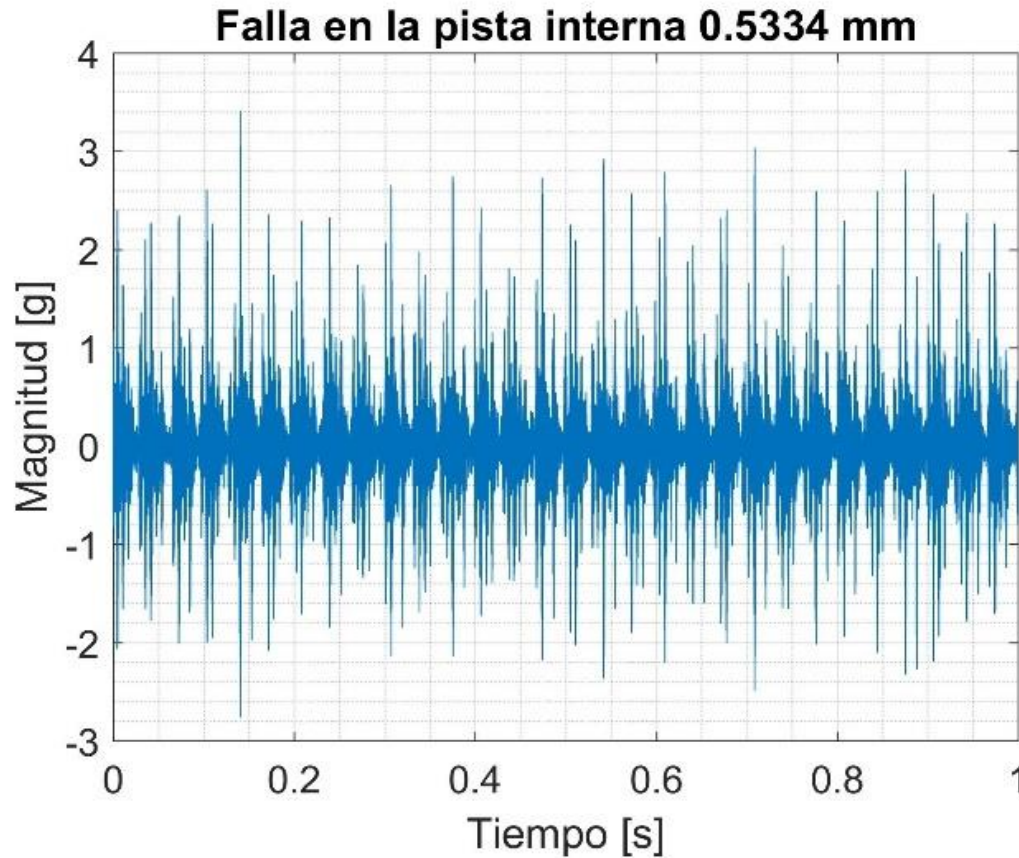
# Datos experimentales

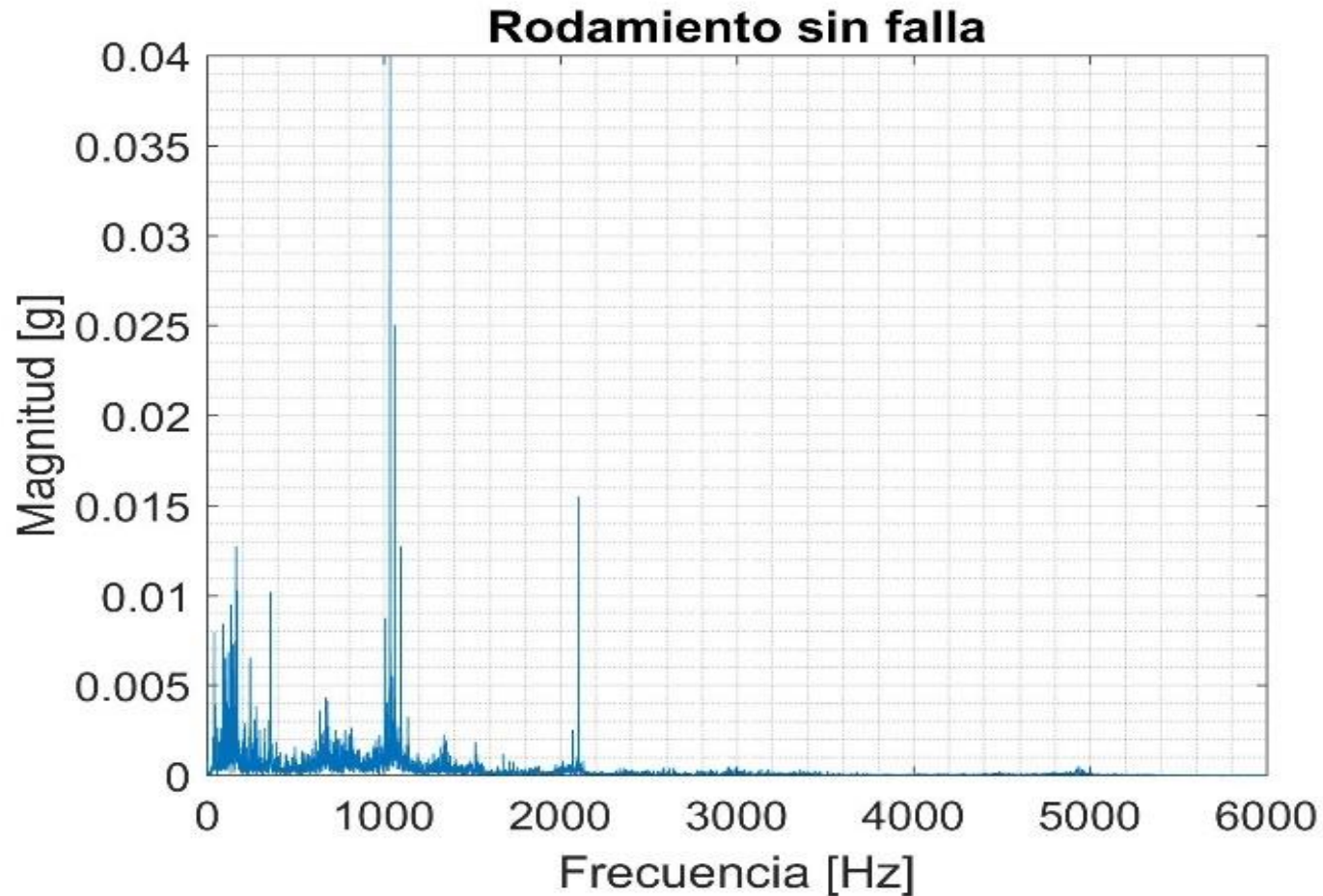






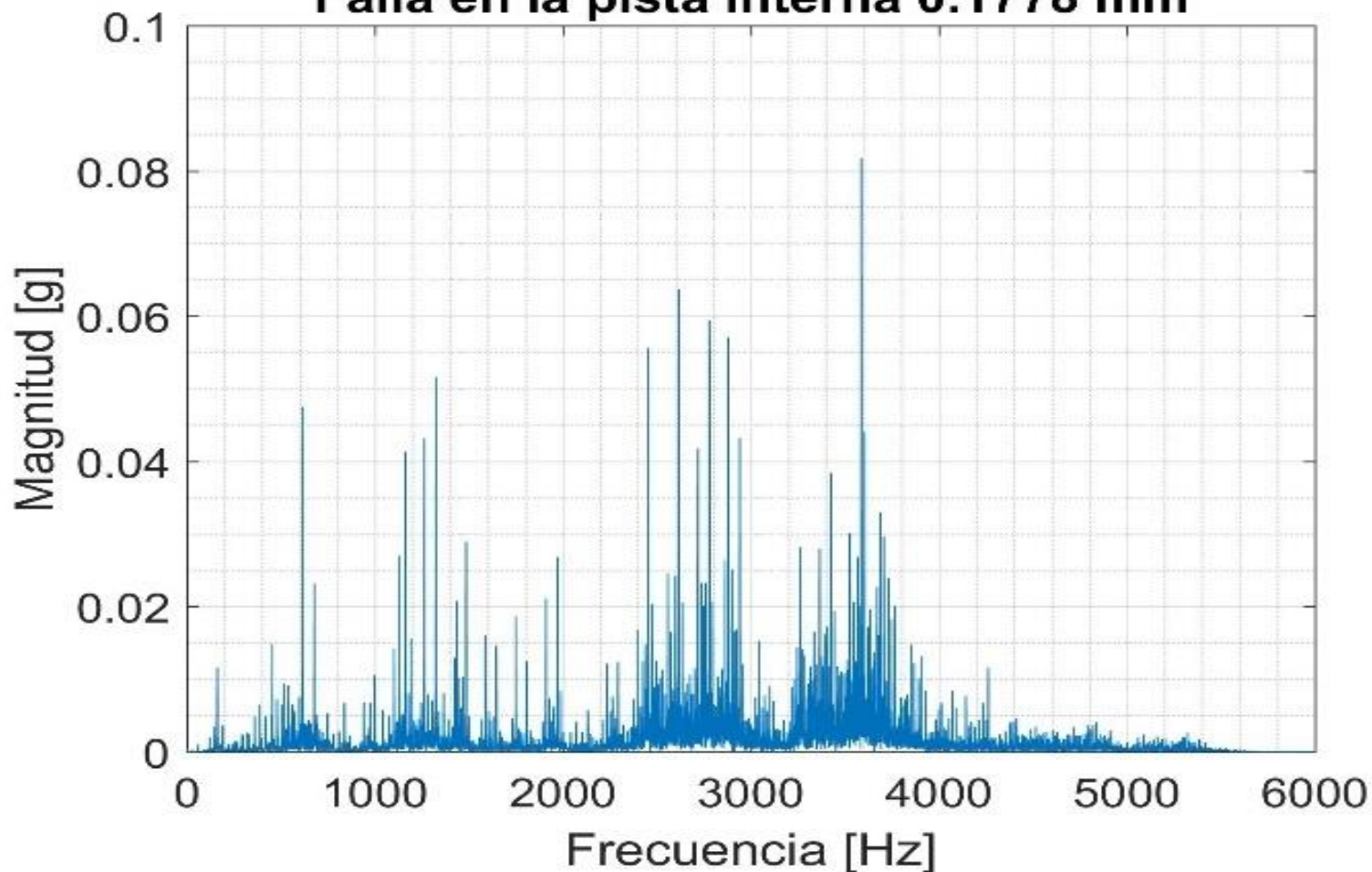


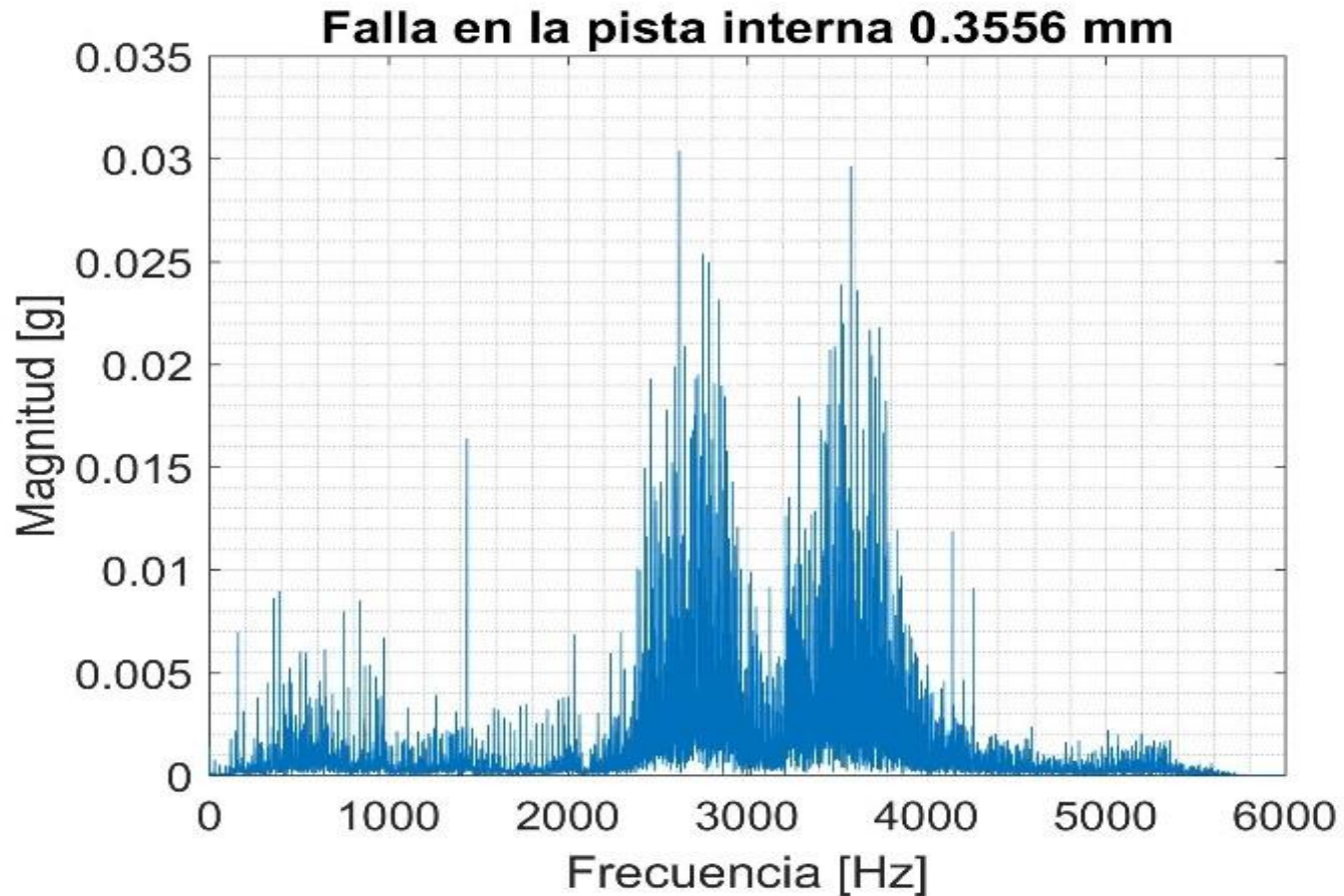




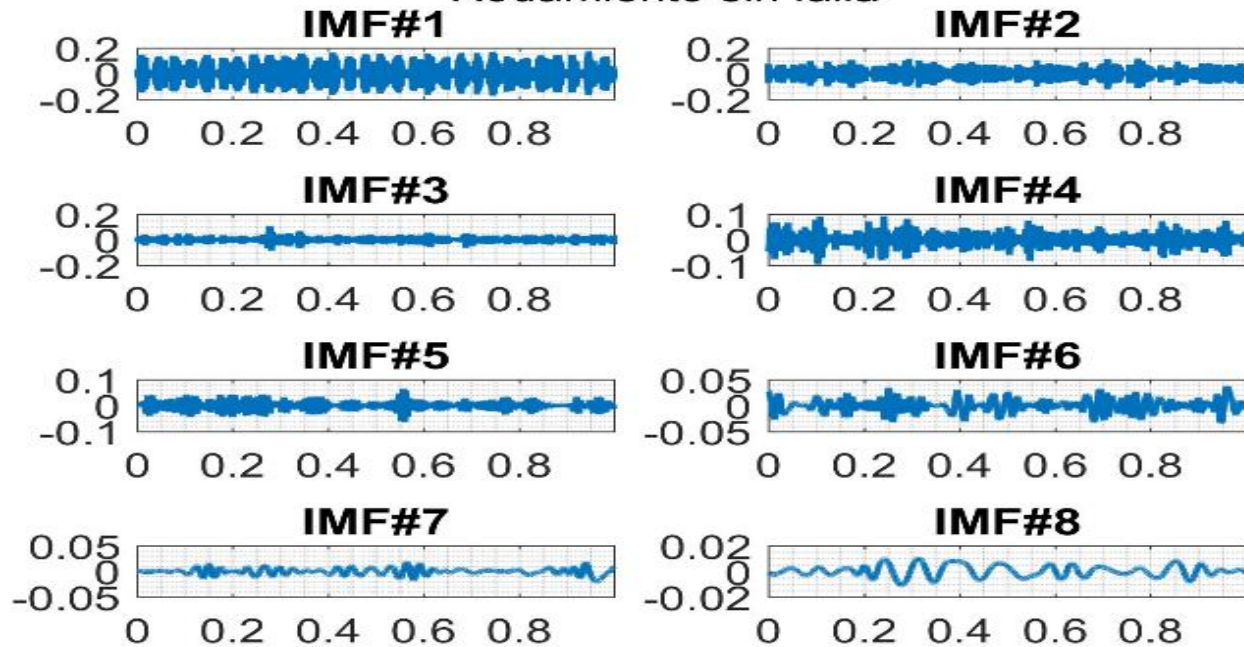


### Falla en la pista interna 0.1778 mm

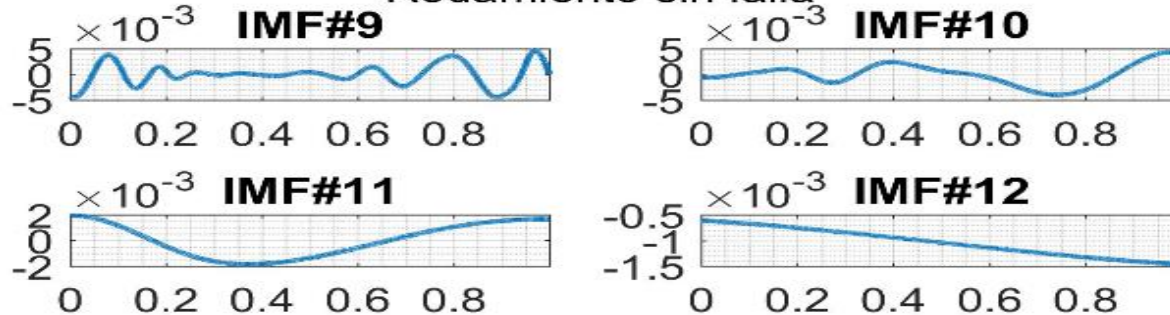




Rodamiento sin falla

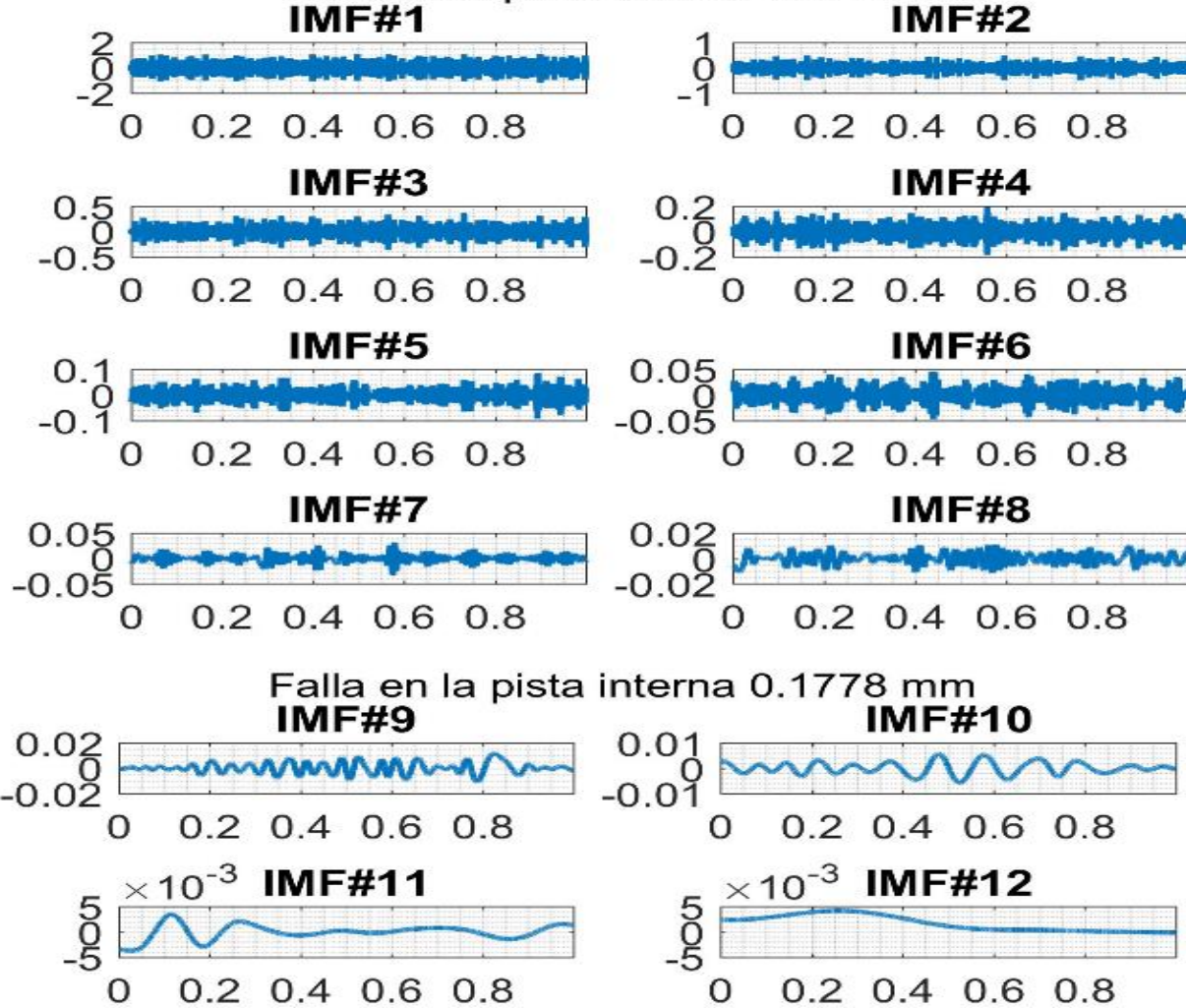


Rodamiento sin falla

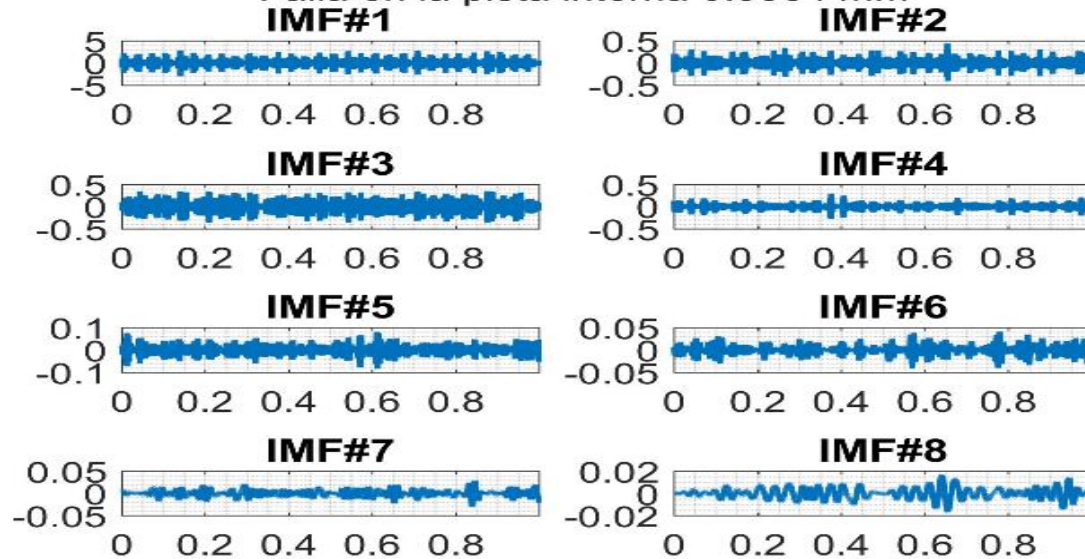




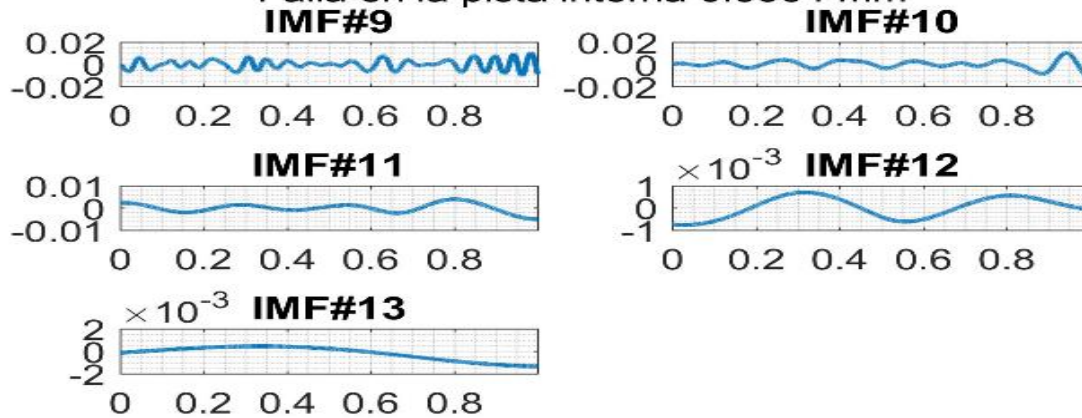
Falla en la pista interna 0.1778 mm

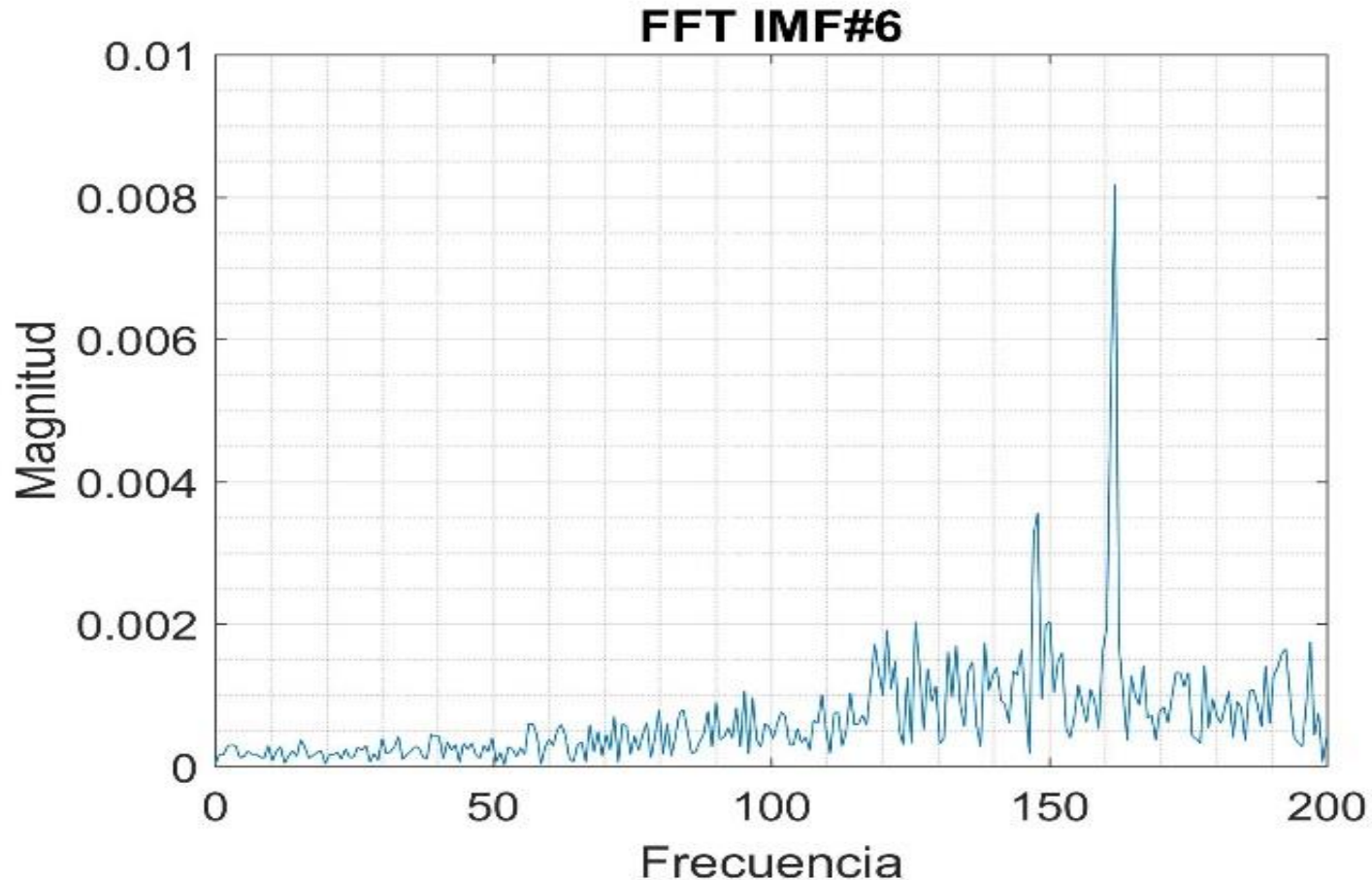


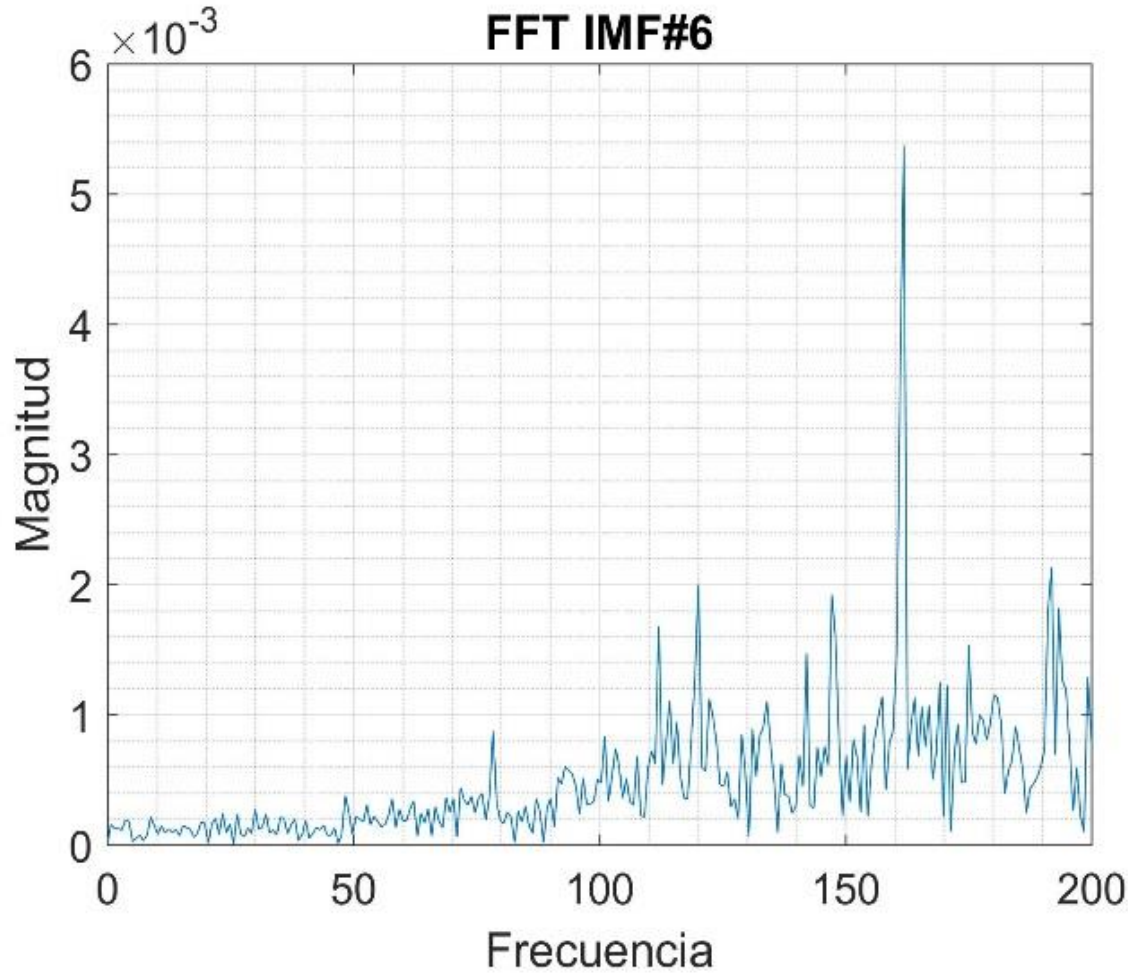
Falla en la pista interna 0.5334 mm



Falla en la pista interna 0.5334 mm







# Cuantificando la severidad

$$\bullet E_i = \sqrt{\frac{1}{N} \sum_{i=1}^N h_i^2} \quad (3)$$

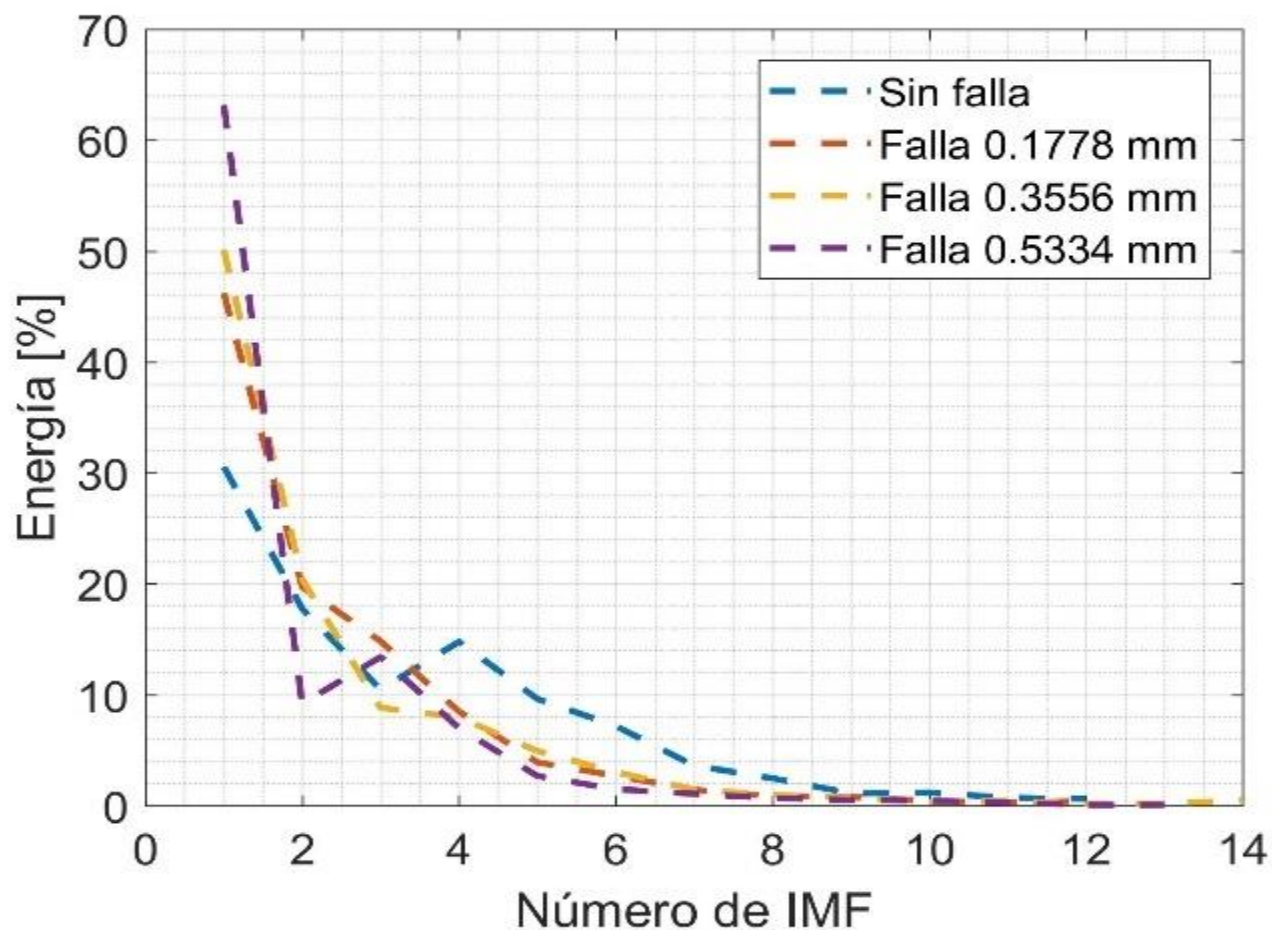
Energía de cada IMF

$$E = \sum_{i=1}^m E_i \quad (4)$$

Energía total de la señal

$$P_i = \frac{E_i}{E} \quad (5)$$





# Conclusiones

- Se presenta una herramienta alternativa en el diagnóstico de fallas en rodamientos
- Posibilidad de
- Método para procesar señales no estacionarias y señales producidas por procesos no lineales





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