

Advanced Generator Protection and Monitoring Using Transducer Measurements

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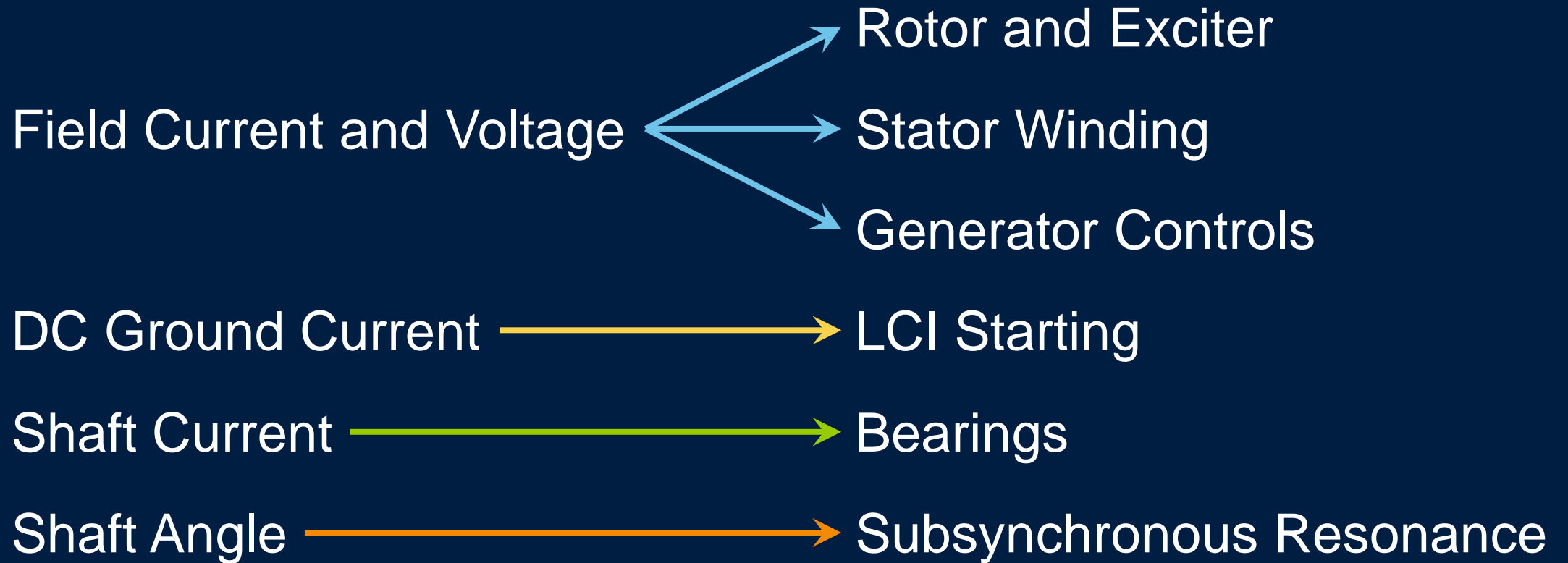
Overview

- Brief review of filtering
- Applications
- Conclusions

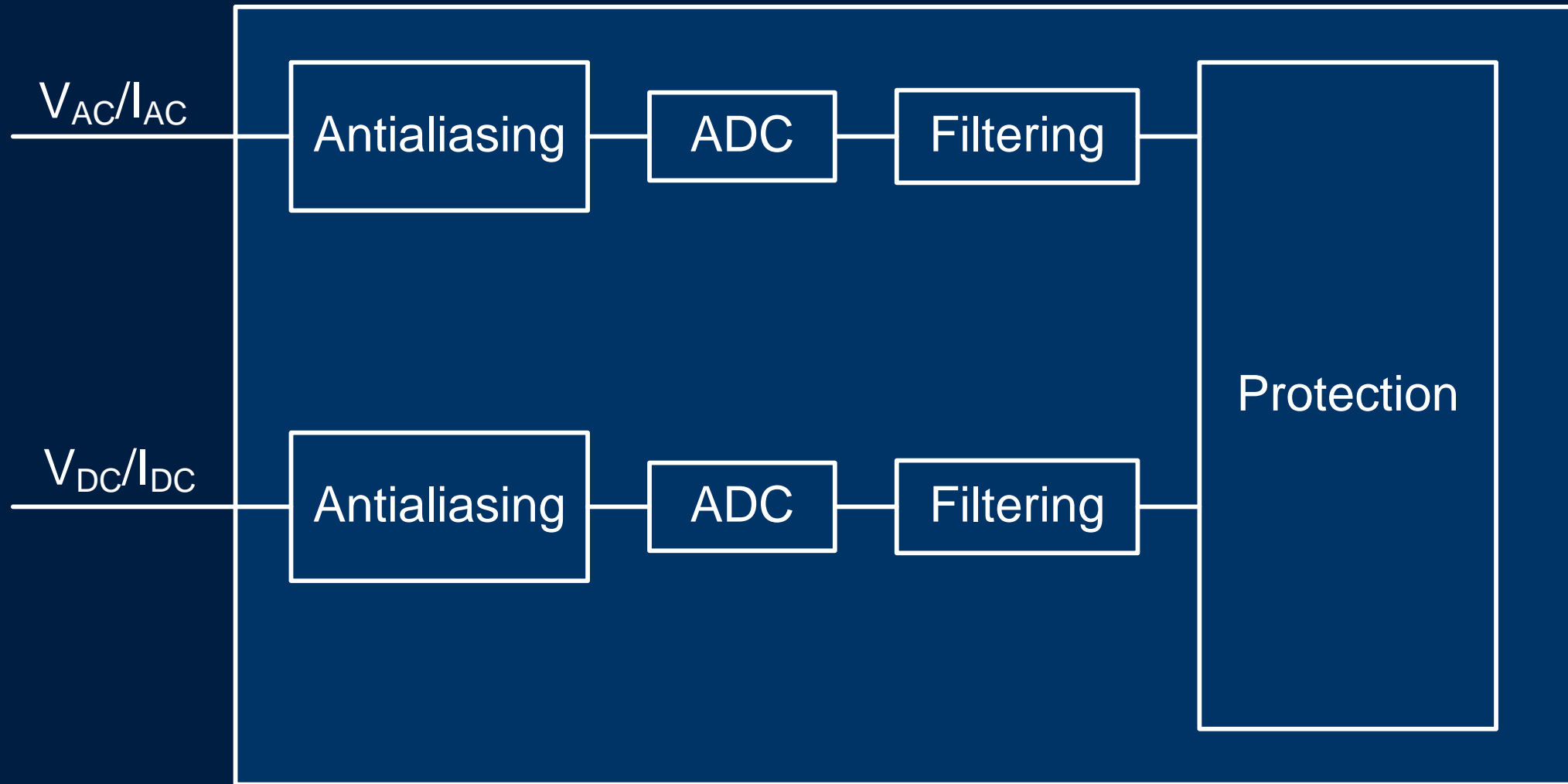
Protection Enhancements

Measurements

Applications

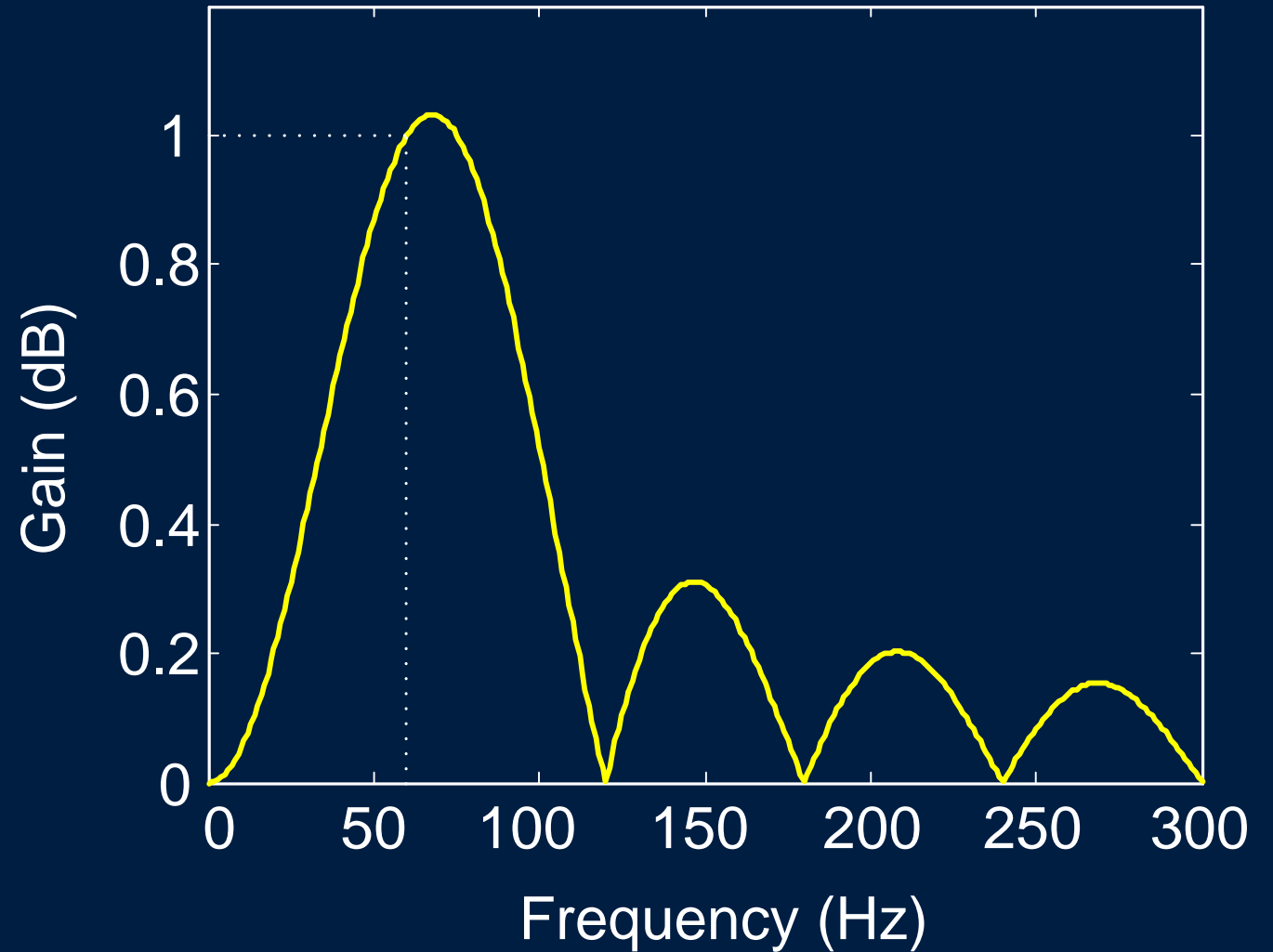


Typical Relay Data Acquisition System



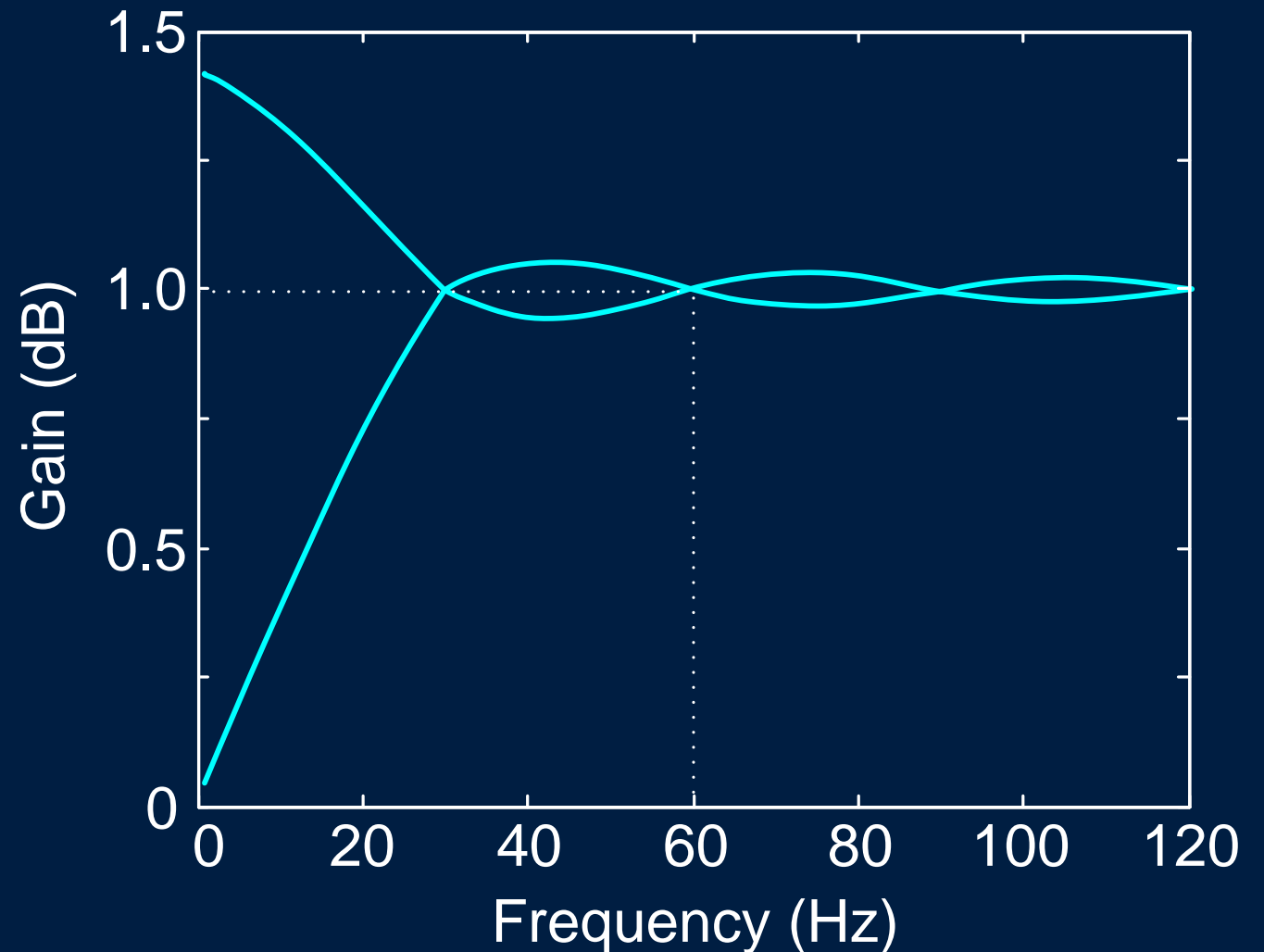
Full-Cycle Cosine Filter

- Frequency-specific
- Reject dc and the harmonics
- Suppresses inter harmonics



RMS Filter Under- and Overestimates Magnitude

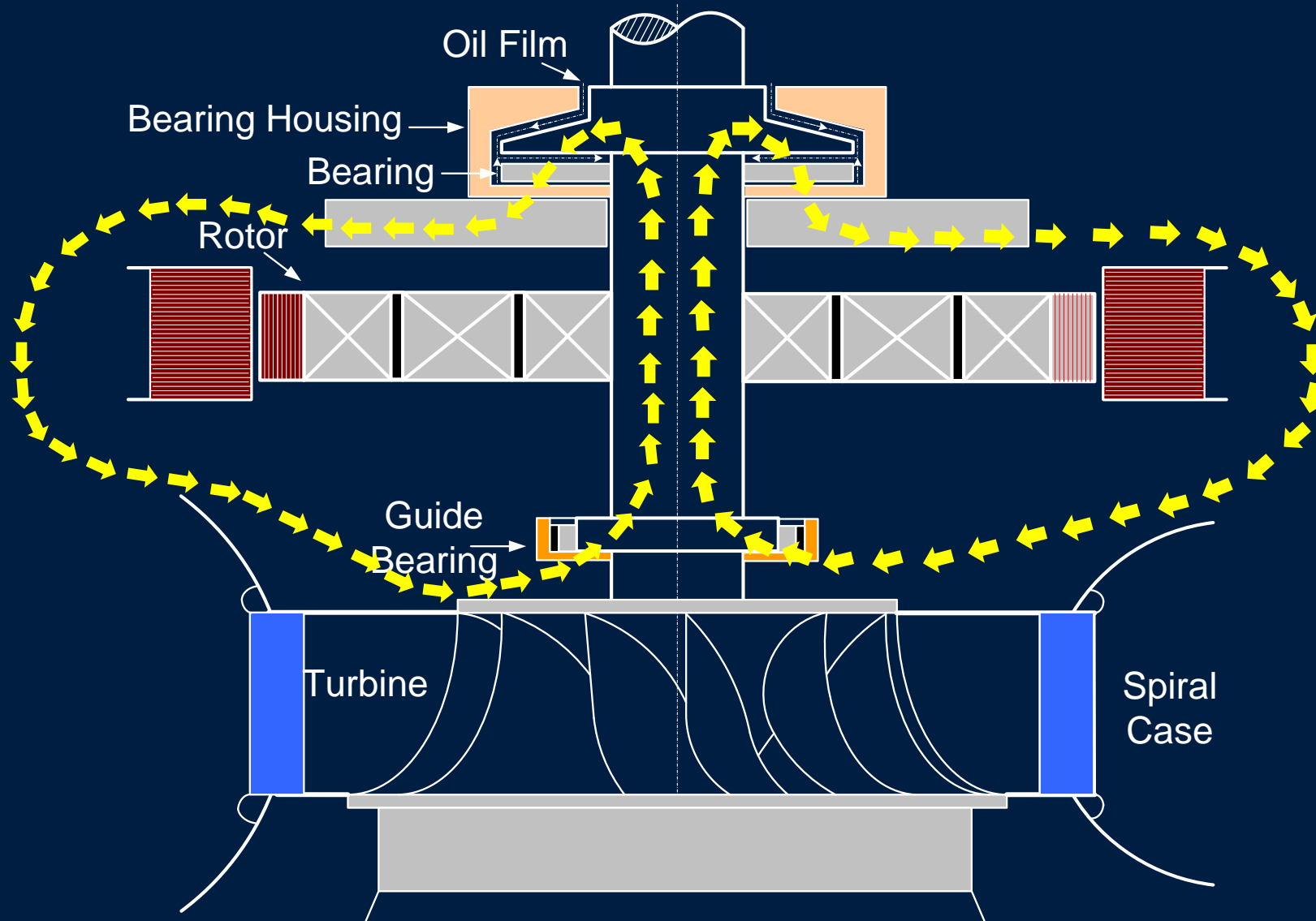
- Includes all frequencies
- Ideal for thermal protection elements



Applications

- Field quantity measurements
- DC ground fault protection
- Stator-field differential protection
- Generator control monitoring
- Subsynchronous resonance
- Generator shaft currents

Generator Shaft Currents



Damage to Thrust Bearing

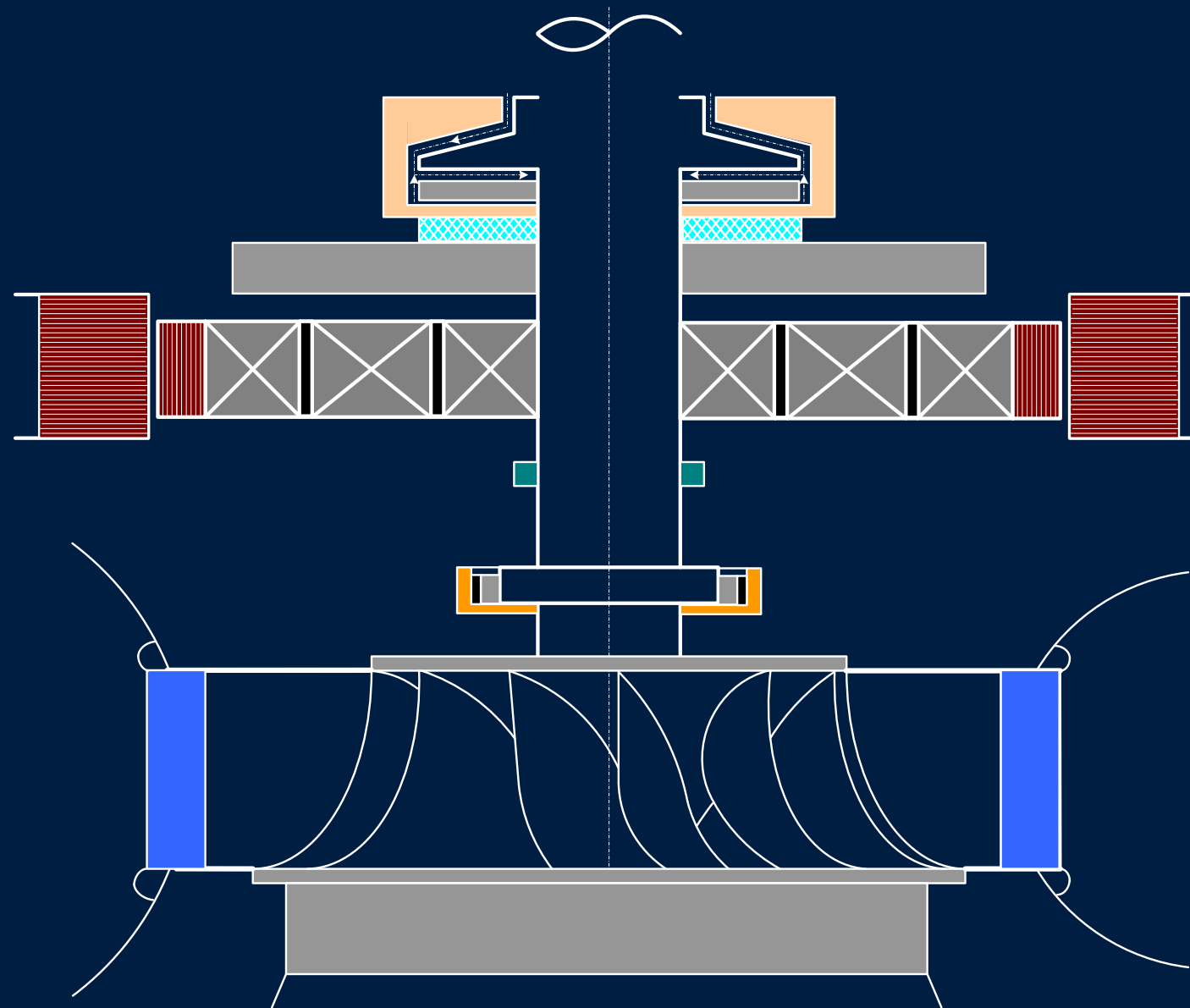
- Shaft current causes arcing
- Arcing removes metal from bearing face
- Guide bearing was also damaged



Closer Look at Damage to White Metal Thrust Bearing



Preventing Shaft Current From Flowing

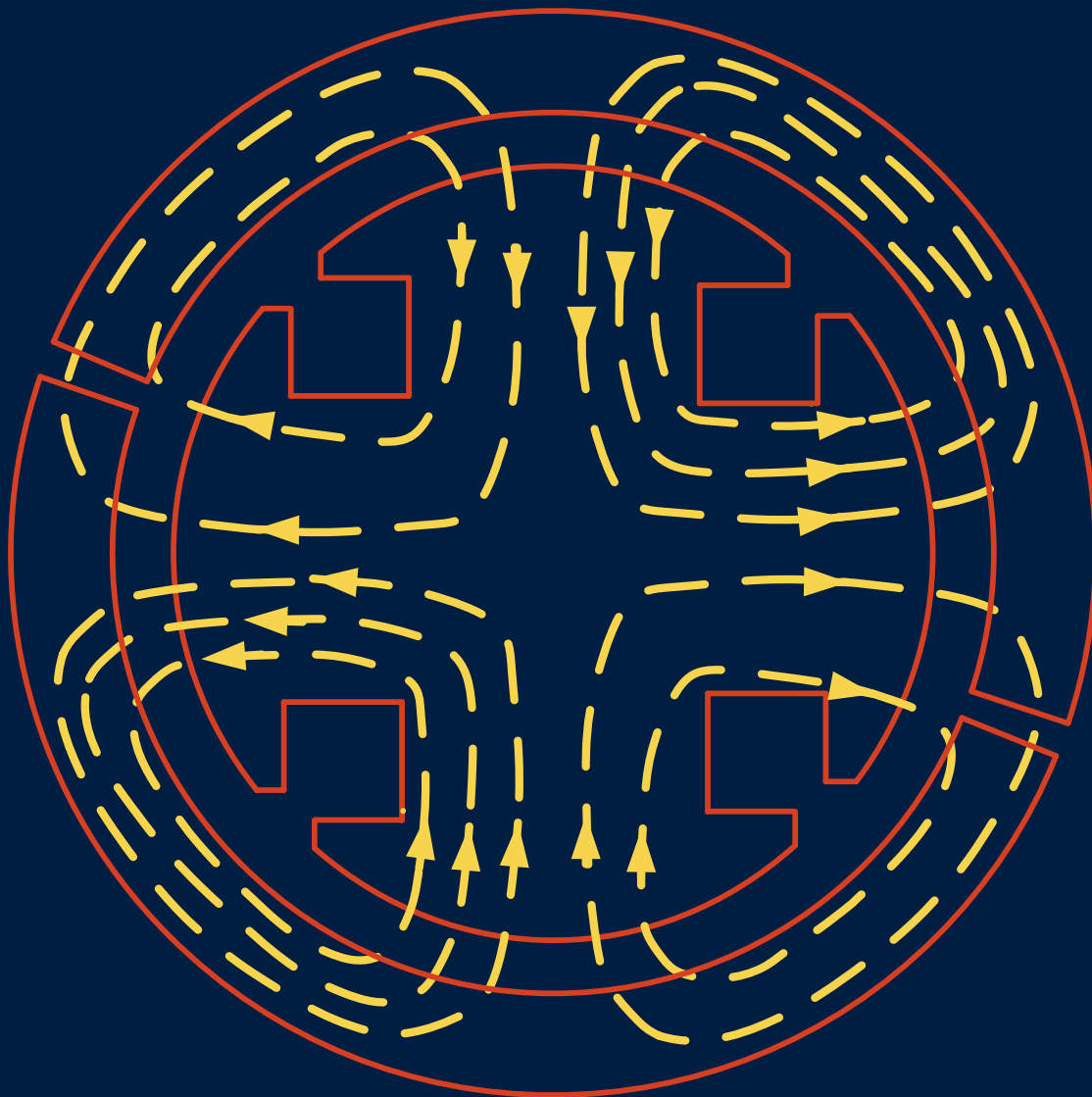


Detection of Shaft Currents

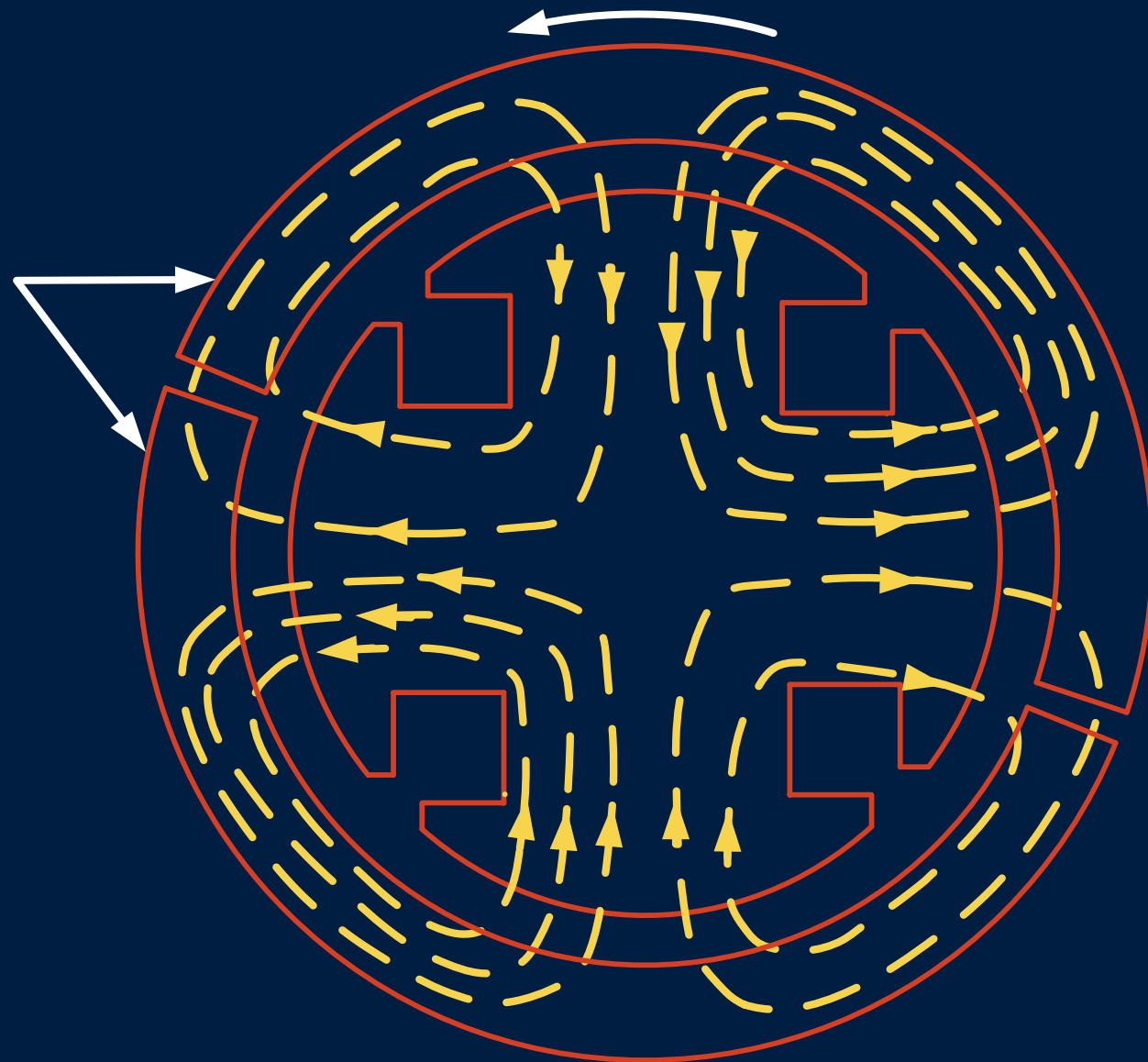
- Monitoring shaft voltage is not effective
- Monitoring shaft current is best
- Requires shaft CTs



Initial Rotor Position

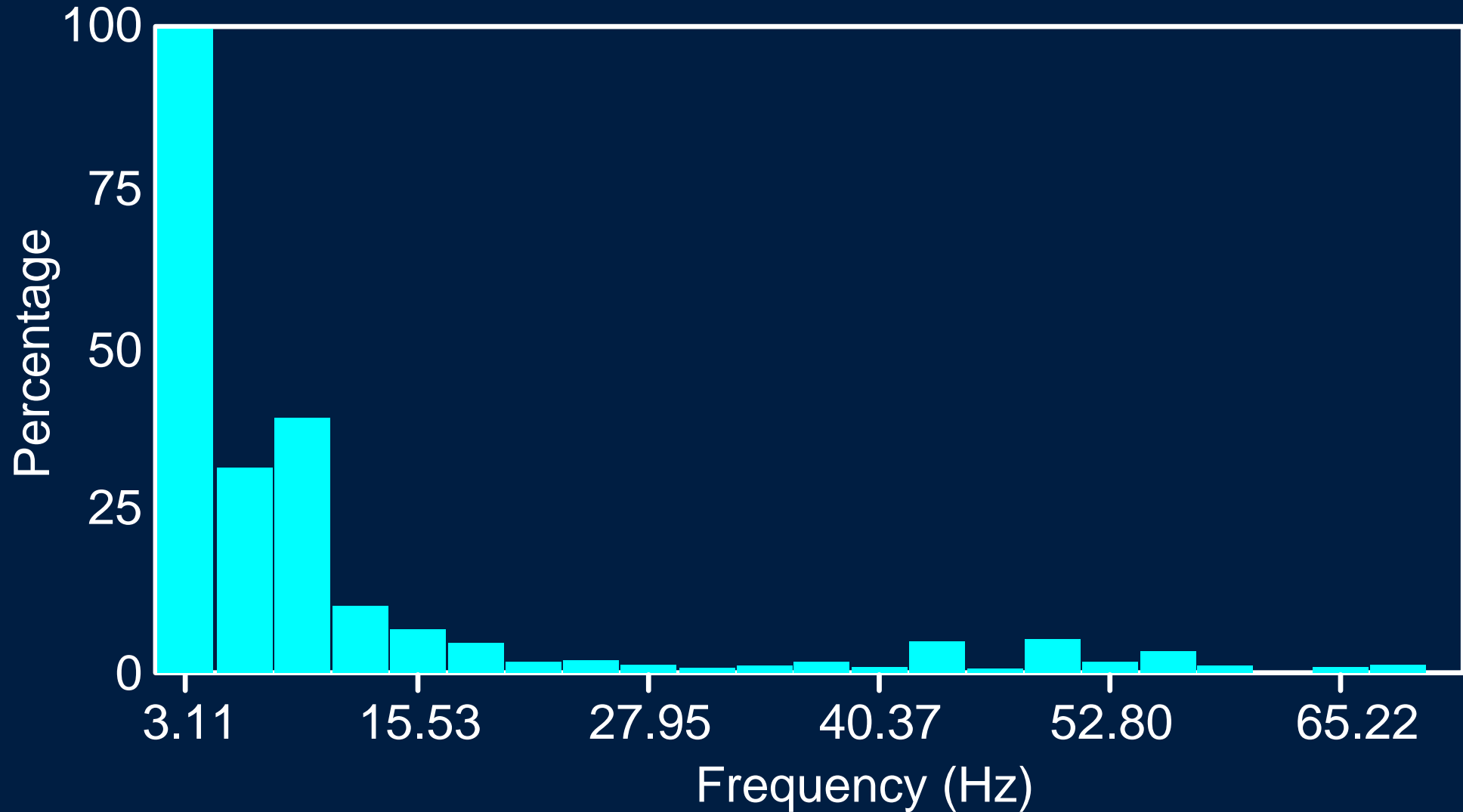


Position After One-Pole Pitch Rotation

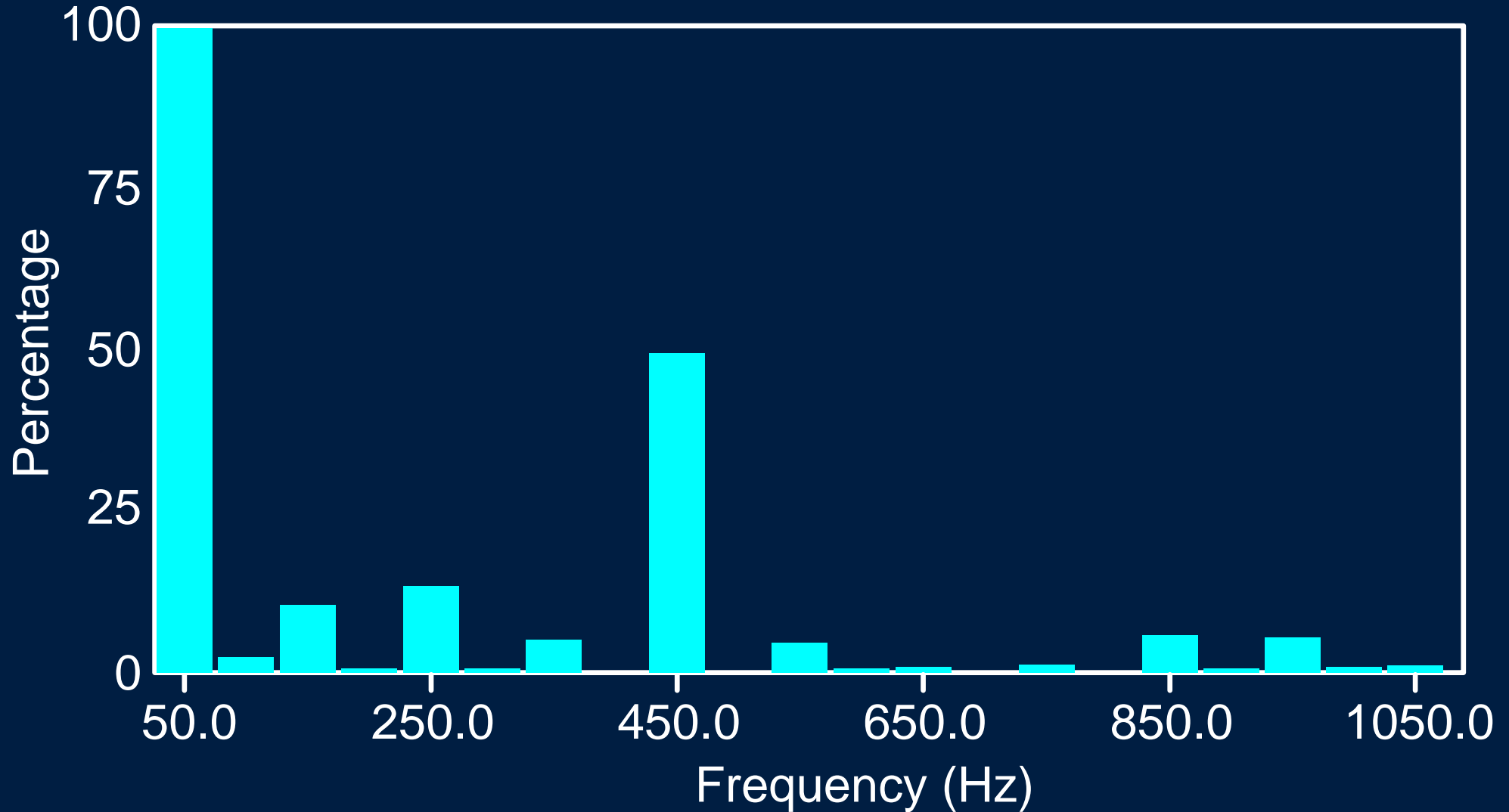


$$k = \frac{\text{\# of segments}}{\text{\# of pole pairs}}$$

No Shaft Current Frequency Spectrum



Shaft Current Frequency Spectrum (2 A Primary)



Rogowski Coil

- Flexible and easy to install
- Need to select integrator range correctly



Conclusions

- Additional generator measurements such as field voltage and current complement traditional protection
- Additional generator measurements increase the level of observability of the generator
- This allows generators to be operated more efficiently and economically



Questions