



MobiSys 2026

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Reliable Metal Foreign Object Detection for Mobile Wireless Charging via Harmonic Fingerprinting

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Wireless charging is everywhere

Bedside



Workspace



Car Mount

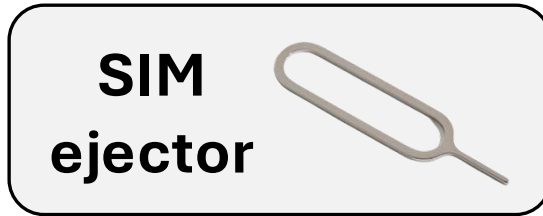


**80% of flagship
phones**

**\$168B Market by
2034**

Convenience comes with a hidden safety risk

Everyday metal objects sneak in — and burn



**Clip Ring
Chip ...**

Easily end up
on charger

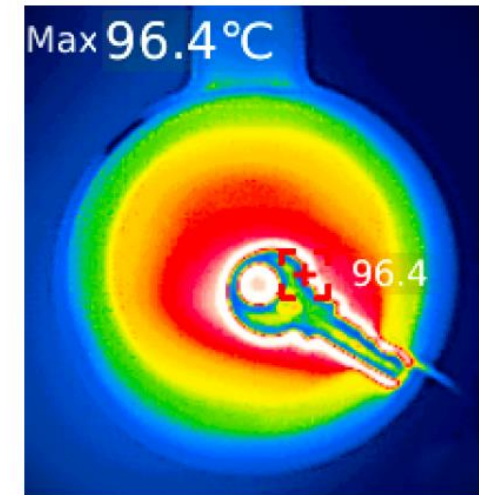


EM field → Eddy currents → Heat up

Burns



Charger + Object



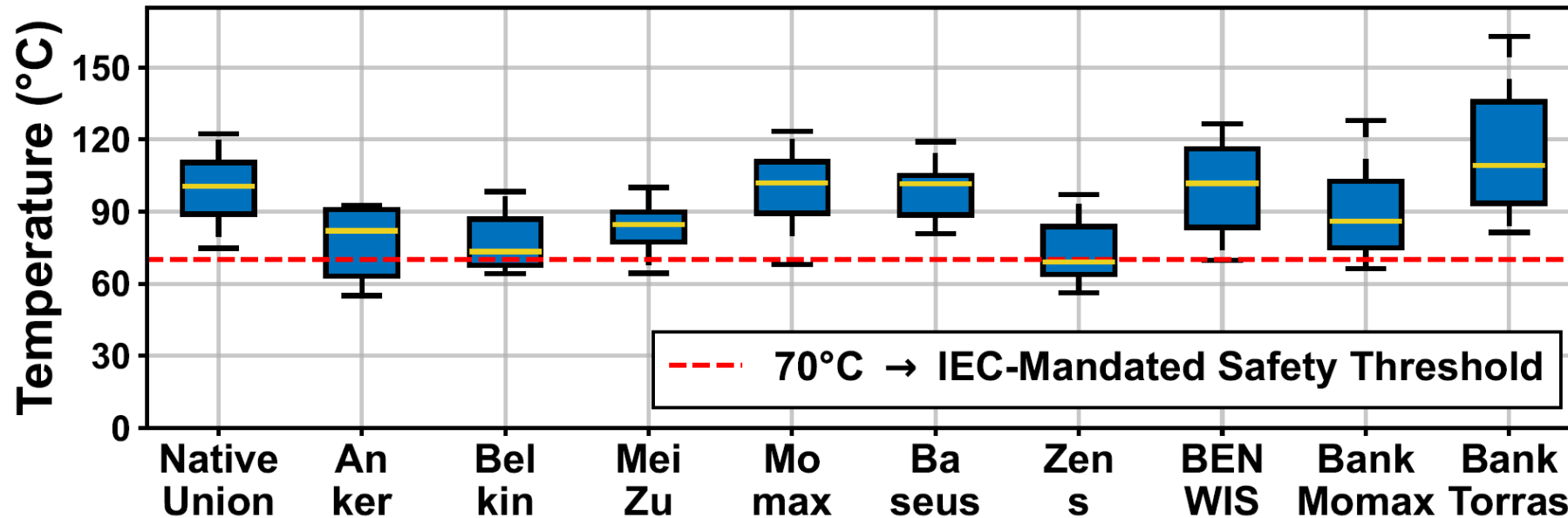
IEC requires detection under 70°C

(International Electrotechnical Commission)

Many commercial chargers fail this requirement

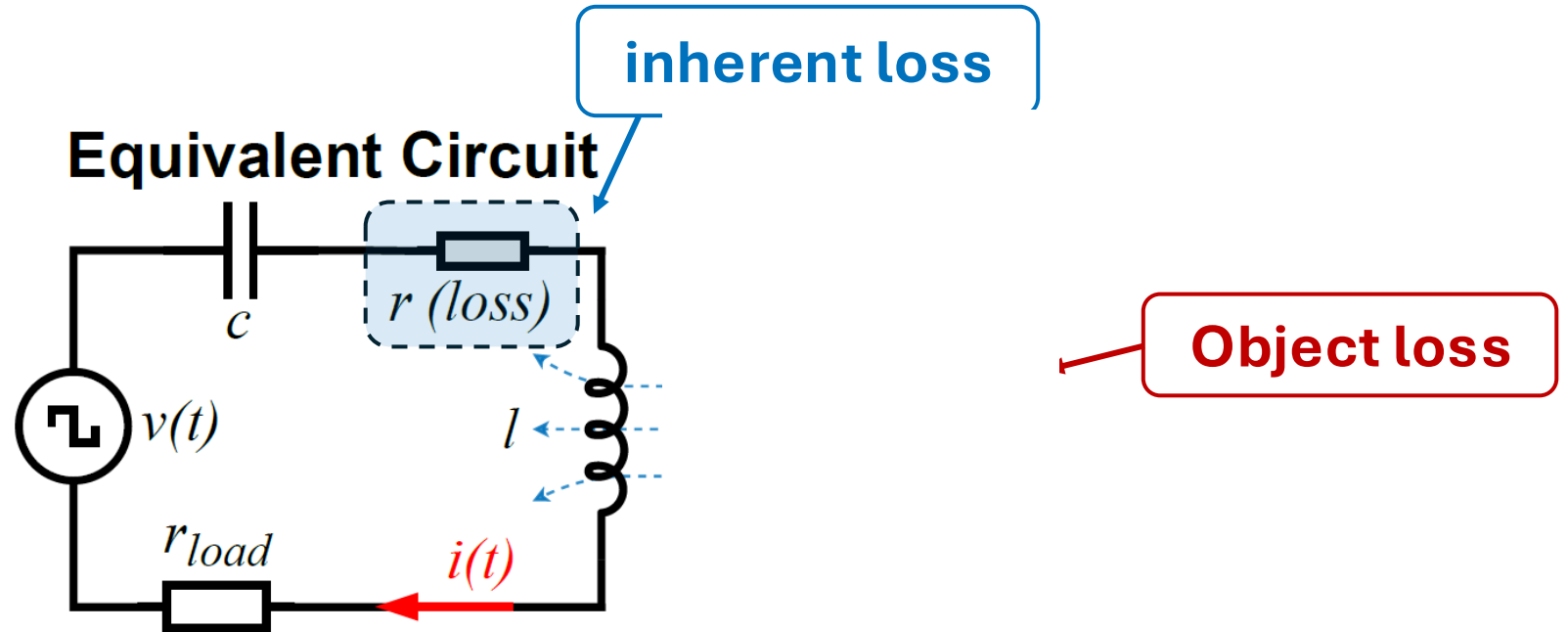
average **93.3°C**

worst case **>150°C**



10 Top-selling chargers from
Asia, Europe, and North America

Why? Energy loss is an ambiguous signal

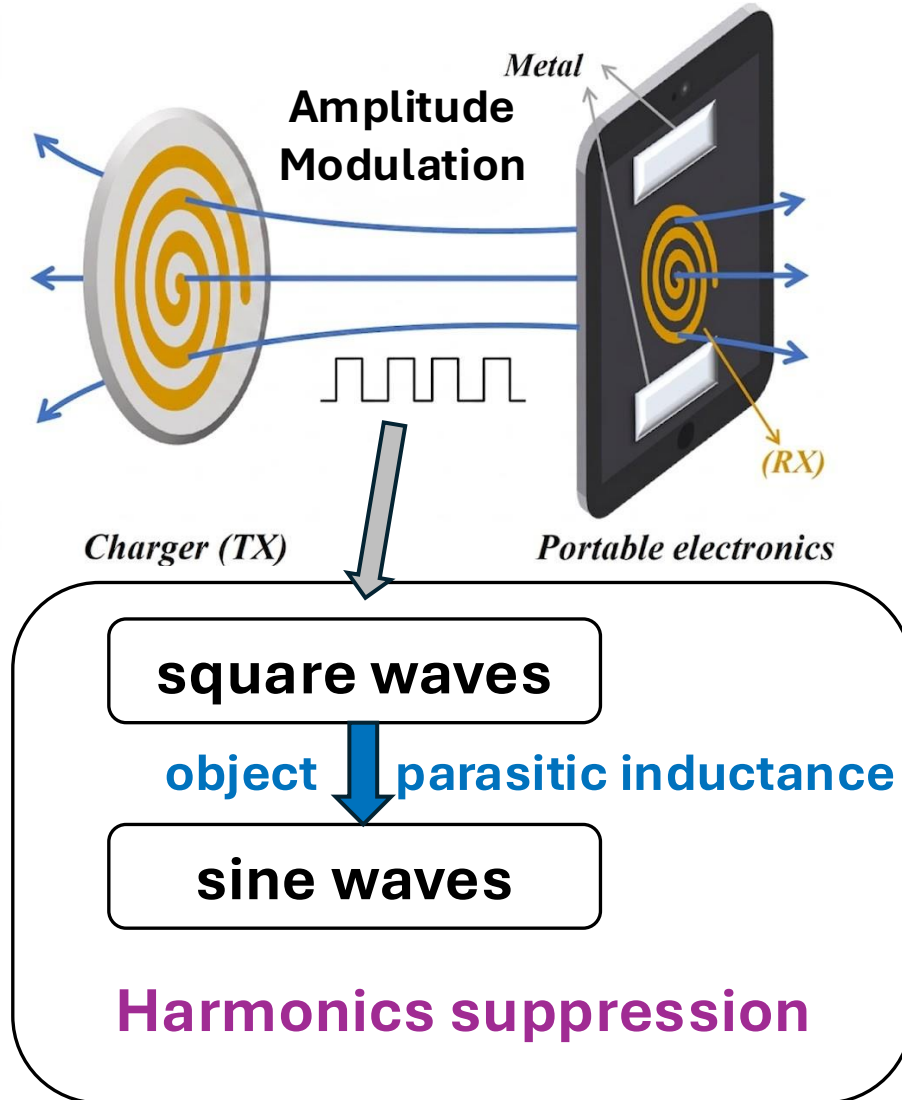


Dilemma:

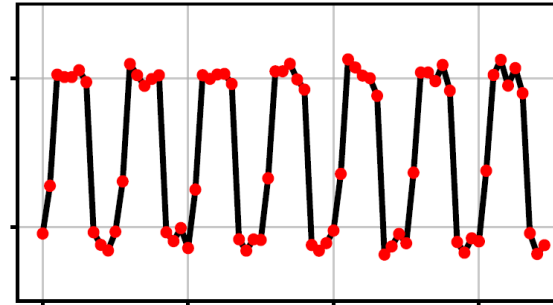
Conservative thresholds → **missed detections**

Sensitive thresholds → **false alarms**

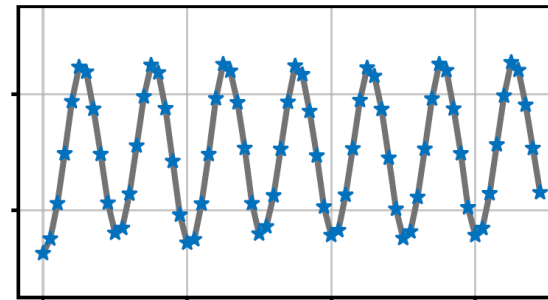
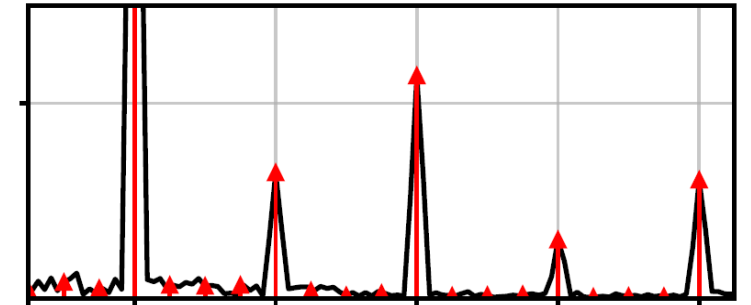
KEY INSIGHT: A metal object acts as a low-pass filter



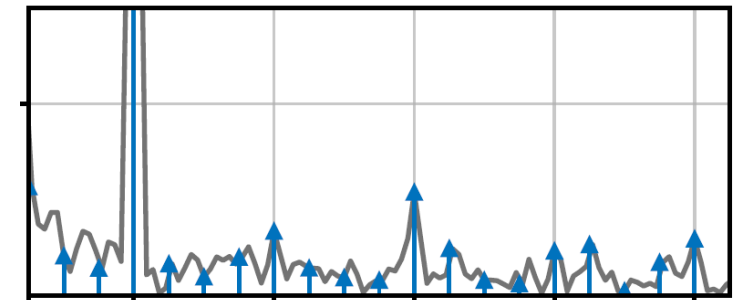
Time domain



Frequency spectrum



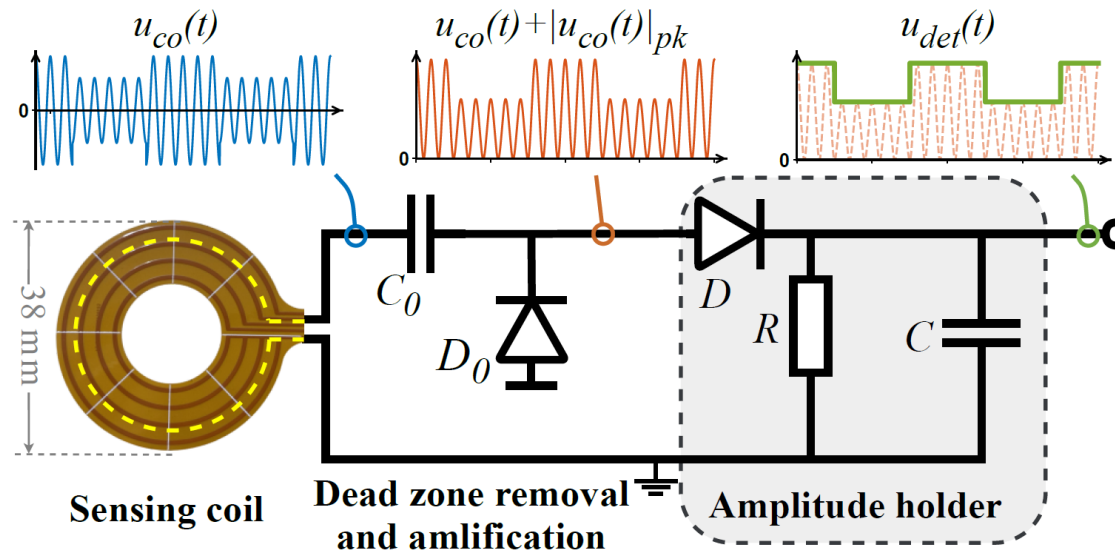
Harmonics above 2kHz are clearly **attenuated**



MetSentry: hardware-software co-design inside the charger

Hardware (capture signal)

- Planar sensing coil array on flexible PCB
- Extractor: dead-zone removal + amplification



Software (extract fingerprint)

- Light-weight network

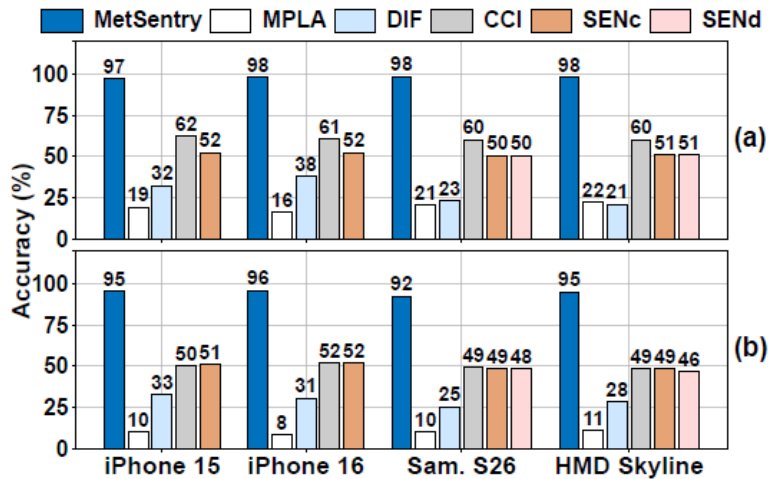
Testbed



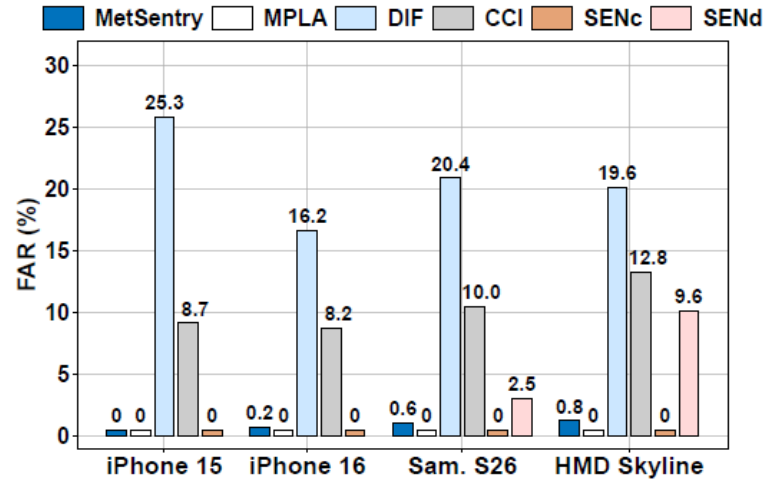
- 14 wireless charger
- 4 mobile phones
- 11 metal objects

Overall Performance

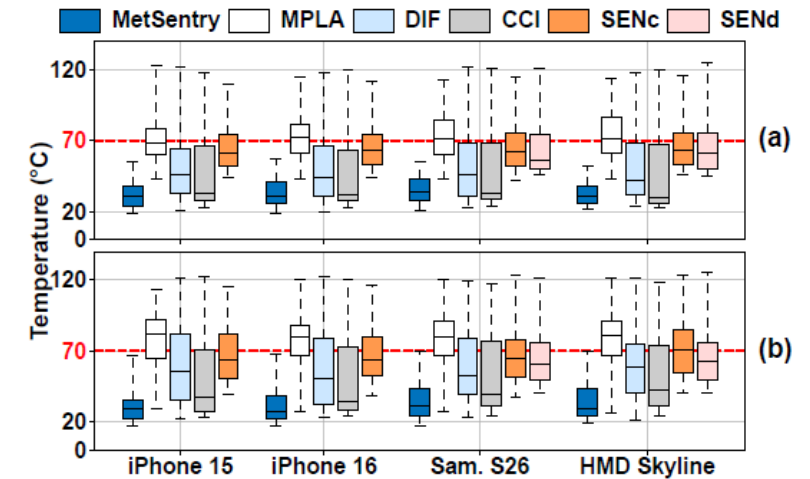
Detection Accuracy



False Alarm Rate



Object temperature



MetSentry:

92--98% accuracy

0.0--0.8% false alarm rate

32°C average detection temperature

Baselines:

- **MPLA** — Energy-loss threshold (commercial)
- **DIF** — Deep Isolation Forest anomaly detection
- **CCI** — Charging current harmonic distortion
- **SENc** — Surface temperature sensor
- **SEND** — Smartphone temperature sensor

Summary

Problem - Commercial methods fail: objects silently heat up to 100°C while remaining undetected

Insight - Harmonic suppression provides a physics-grounded fingerprint

Solution - MetSentry: reliable detection below 70°C through low-cost co-design

Thank you!

Q & A

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