Power Signature for Information Forensics
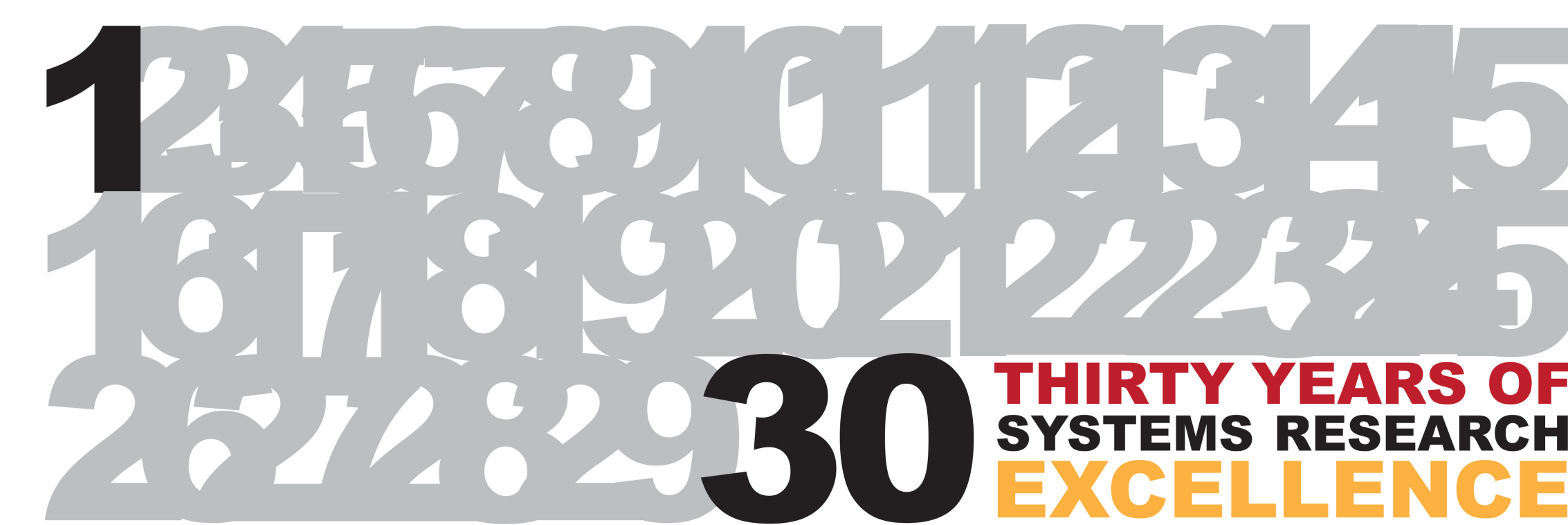
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Media & Security Team at UMD — MAST

30 THIRTY YEARS OF SYSTEMS RESEARCH EXCELLENCE

INSTITUTE FOR SYSTEMS RESEARCH
A. JAMES CLARK SCHOOL OF ENGINEERING
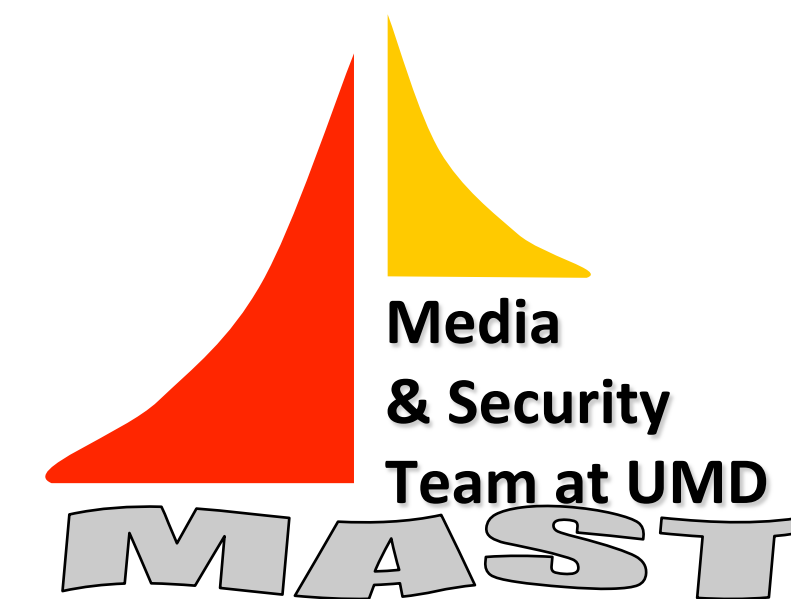
What is ENF?

- **Electric Network Frequency** – nominally 60Hz in North America and 50Hz mostly elsewhere.

- ENF can be captured by audio/video recordings, due to electromagnetic influences.

- ENF fluctuates around nominal value due load changes in the grid.

- Changing instantaneous ENF values over time form the **ENF signal**.

ENF Detection and Extraction

Spectrograms showing matching ENF variations in simultaneously recorded signals

power   audio   video
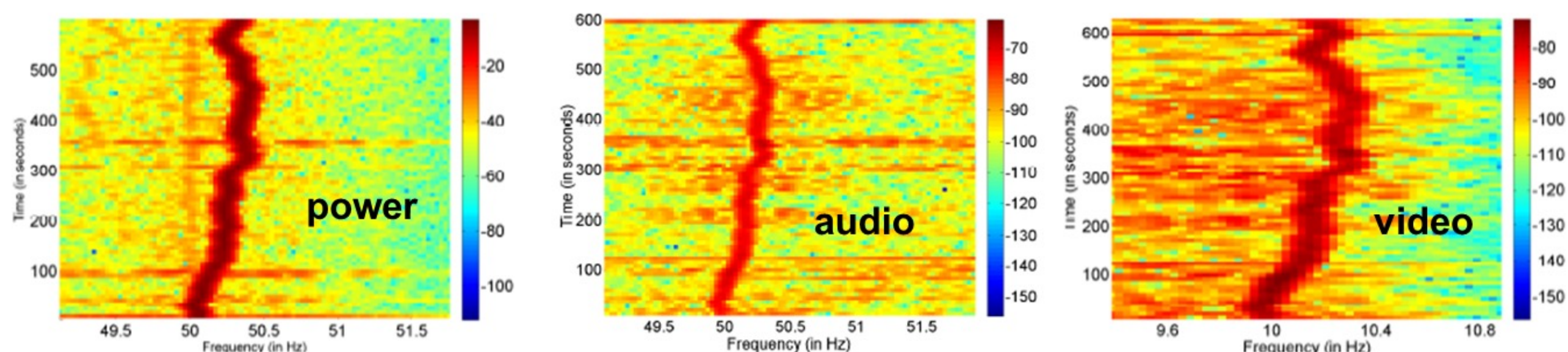
- Light intensity follows a power law with electric current => ENF in video appears at 100/120Hz.

- Aliasing can occur due to lower camera sampling rates: e.g. 29.97fps aliases 100Hz signal to 10.09Hz.

- Can exploit aliasing analysis and CMOS rolling shutter to improve ENF extraction from videos.

- ENF can appear at different harmonics of nominal frequency.

- Strategically combine different spectrum strips for more accurate and robust ENF estimates.
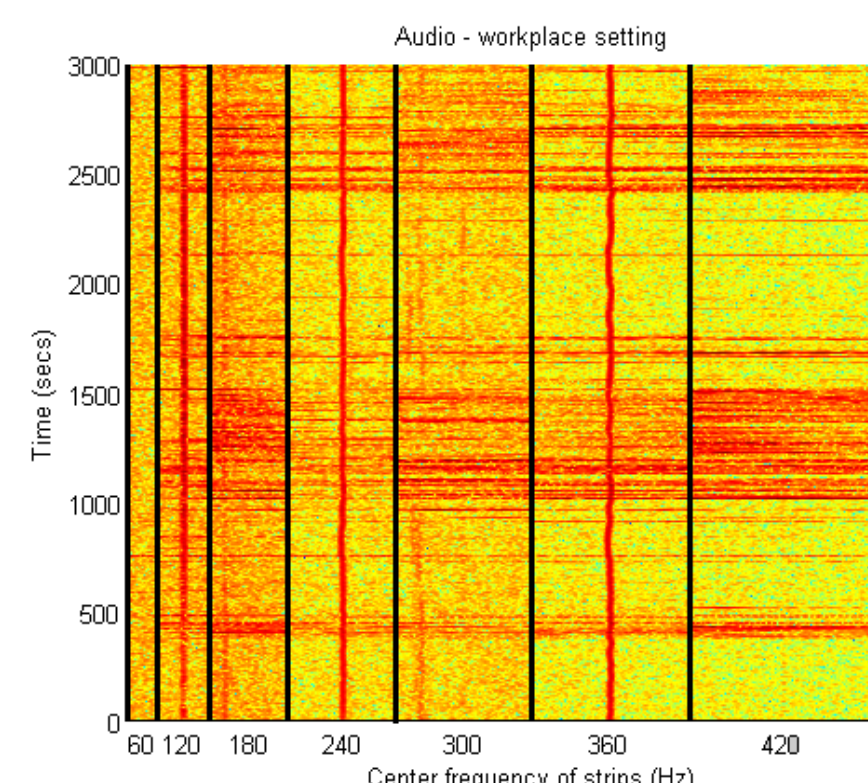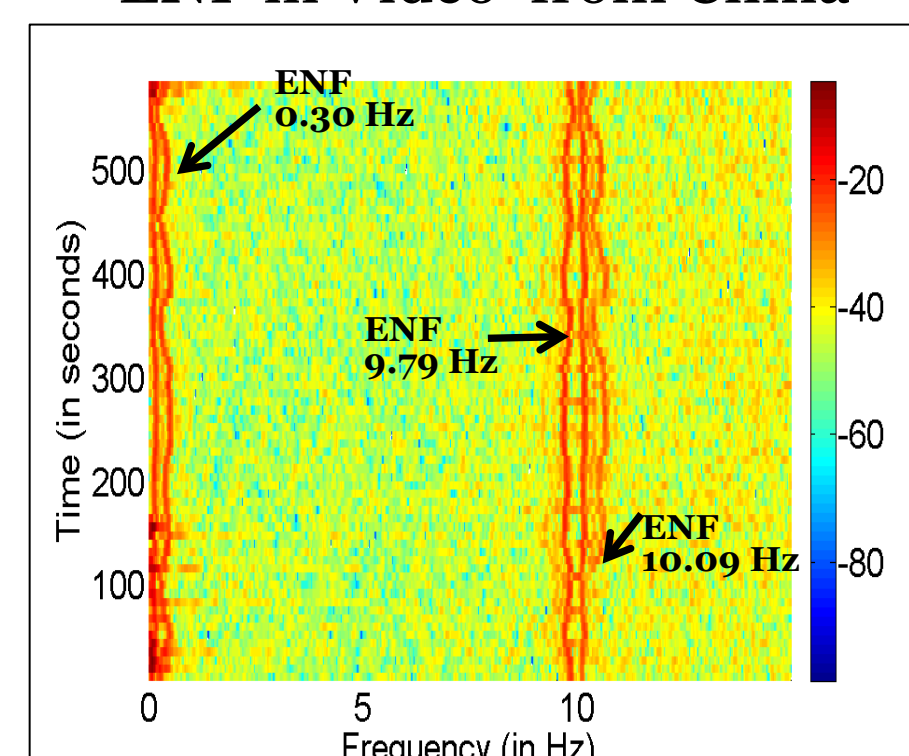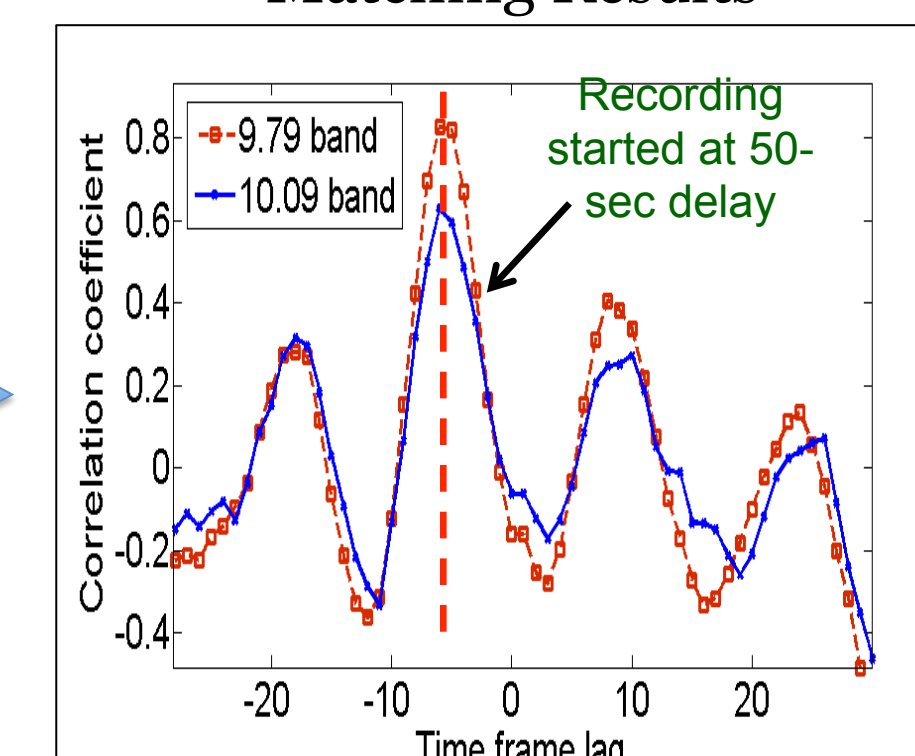

Estimate Time and Location

Time-of-recording estimation

- Compare ENF fluctuations from reference power-ENF with media-ENF.

- Highest correlation between two sets of ENFs corresponds to recording time.


ENF in Video from China   Matching Results

Localization

- Main ENF fluctuations are similar across a grid.

- High-pass details of ENF can help locate the origin of a signal within a grid.

- ENF from different grids can exhibit different statistical properties.

  o Can infer grid-of-origin through machine learning, with no concurrent reference ENF.

Lebanon   India   Eastern US
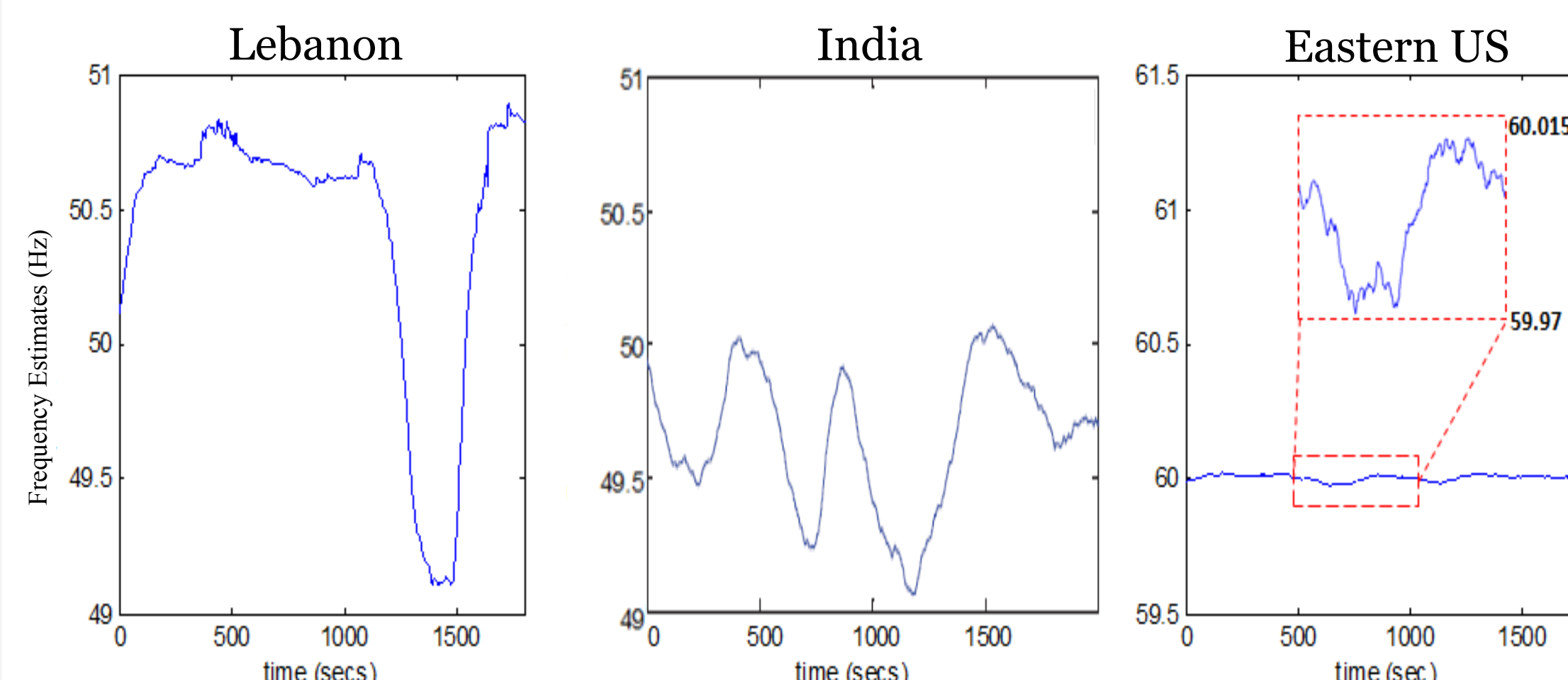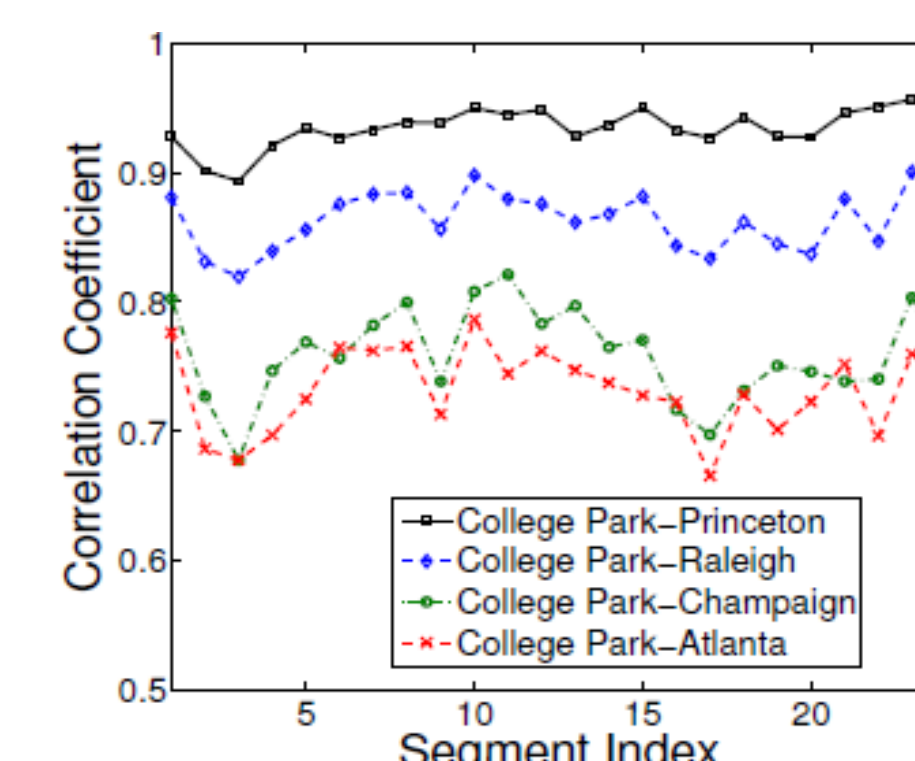
Verify Integrity

- **Insertion/Deletion of media clips** leads to discontinuity in ENF from media.

  o Compare with reference power ENF to obtain further forensic details.

ENF from video   Ground truth ENF
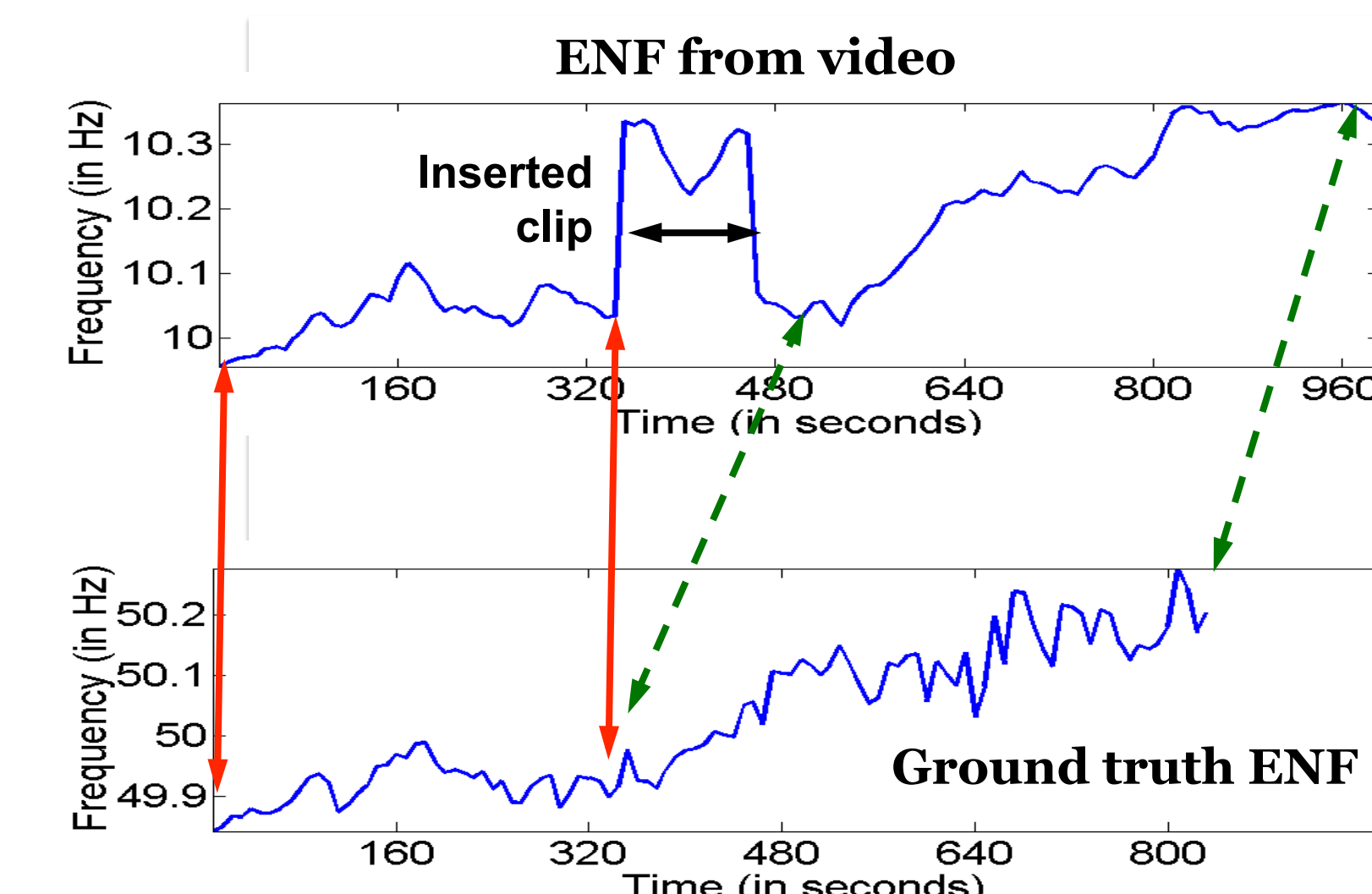
- **Forensic binding**: Is the audio track in the video original or superimposed later?

  o ENF from audio track and from video track should match each other.

  o Reference power-ENF not necessary.

- **Anti-Forensics study**:

  o Possible to remove narrow-band ENF, but much harder to tamper a valid ENF without leaving other traces.

- Can extend to nighttime outdoor scenes:

Video Screenshot   Reference ENF from power measurement   ENF estimated from video signal