

***Acoustic Emission Testing for the
Detection of Localized Corrosion of
Aluminum 2024 alloy in 3.5% NaCl***

Miguel A. González Núñez



**Airlines for
America[®]**

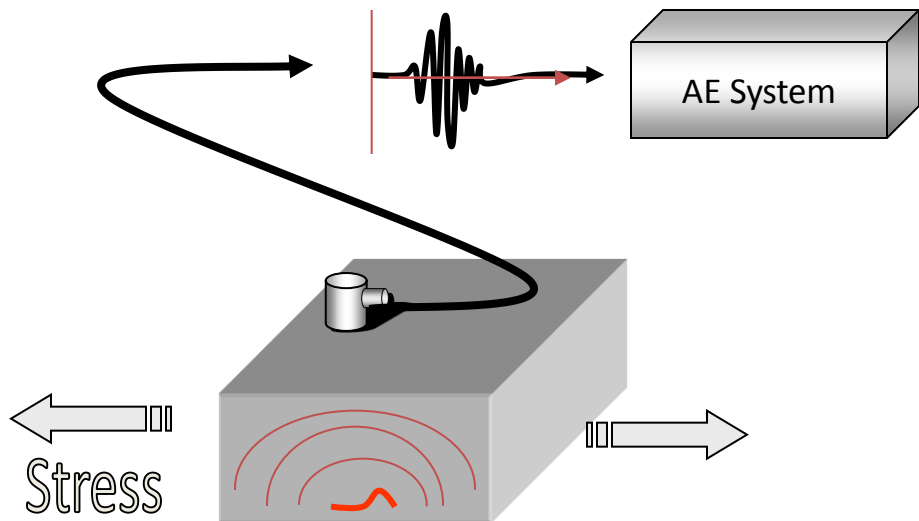
NDT
NONDESTRUCTIVE
TESTING FORUM

OUTLINE

- **Introduction**
- **History of Corrosion Detection with AE**
- **How can we Detect Corrosion with AE?**
- **Potential Sources of AE during Active Corrosion.**
- **AE Measurements in Controlled Corrosion Experiments**
- **Results**
- **Conclusions**
- **Future Work**

Introduction

Acoustic Emission

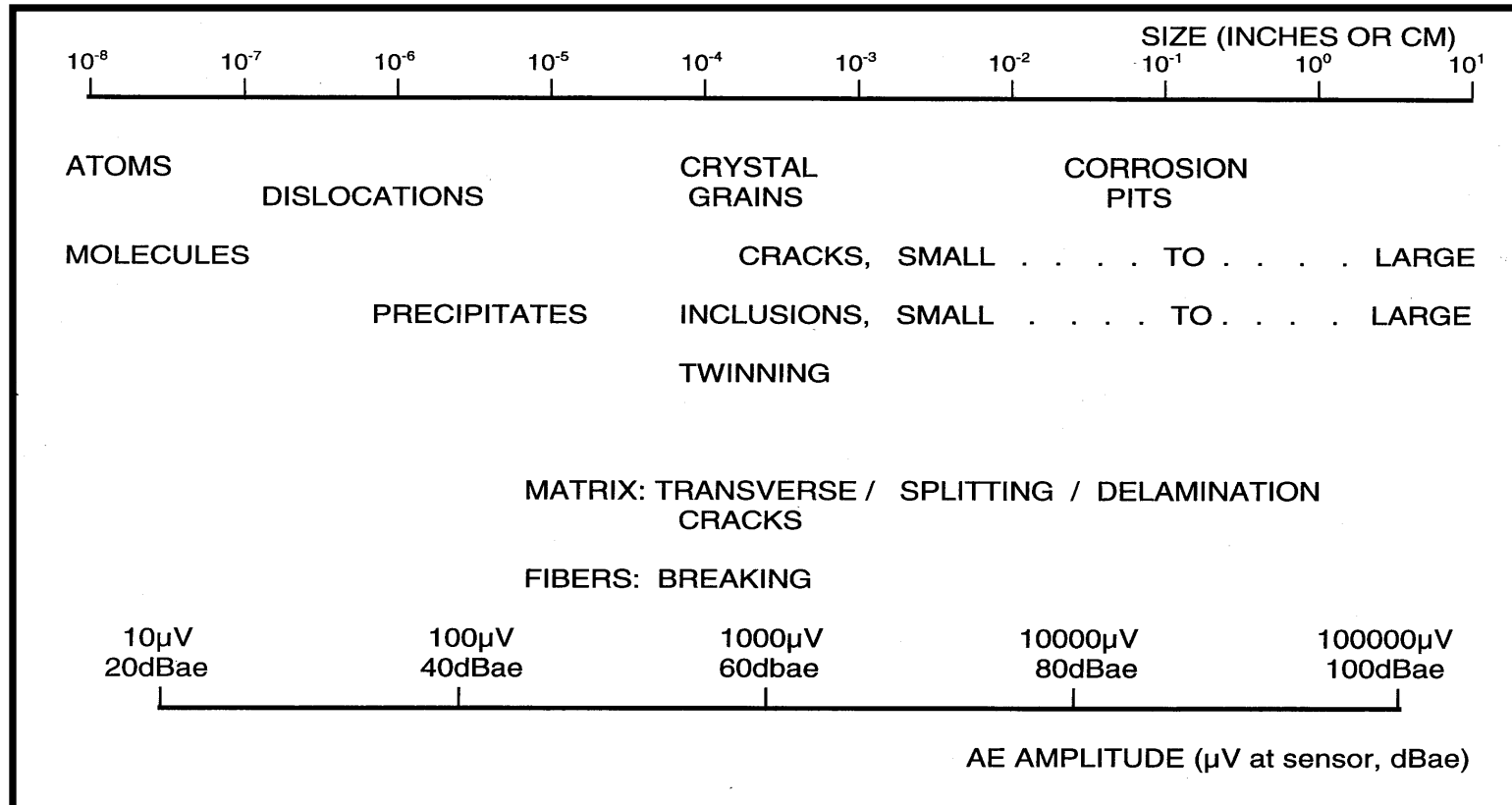


- ◆ AE detects **GROWING** defects within the material under loading and **ACTIVE** damage
- ◆ Real time method

AE : Stress Waves due to Sudden Movements in Materials

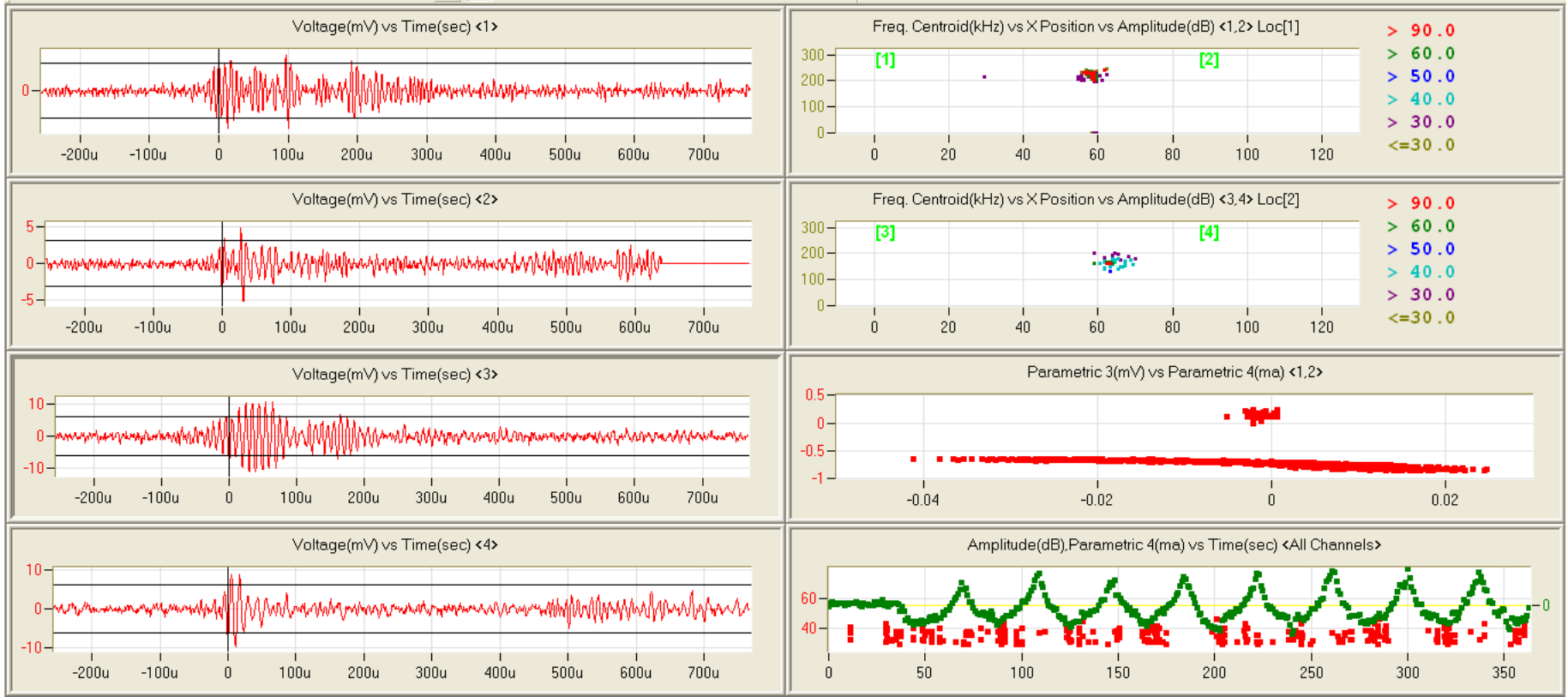
Introduction

Scale of AE Source Processes

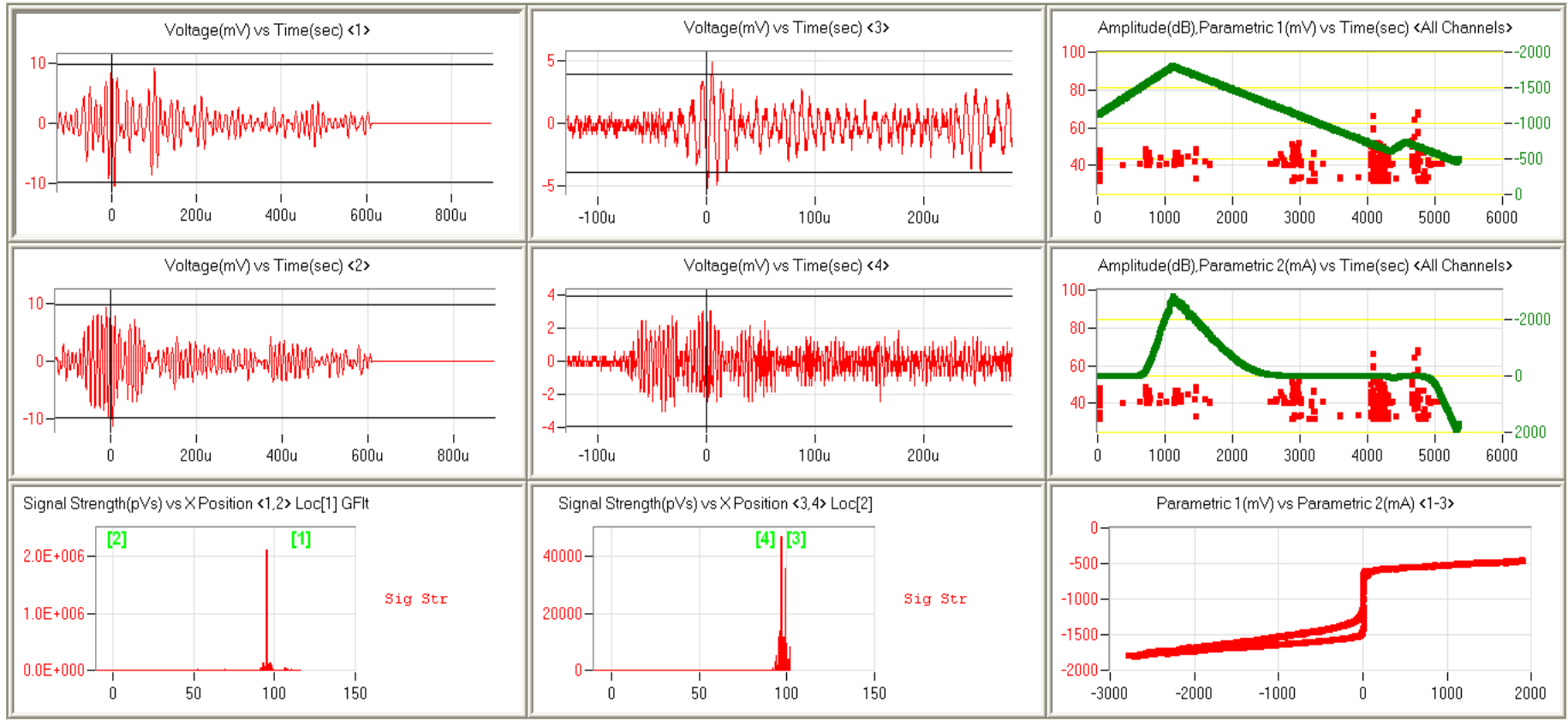


AE Source Amplitude will be Governed by (a) Size, (b) Speed of Source Event

Initial Corrosion experiments

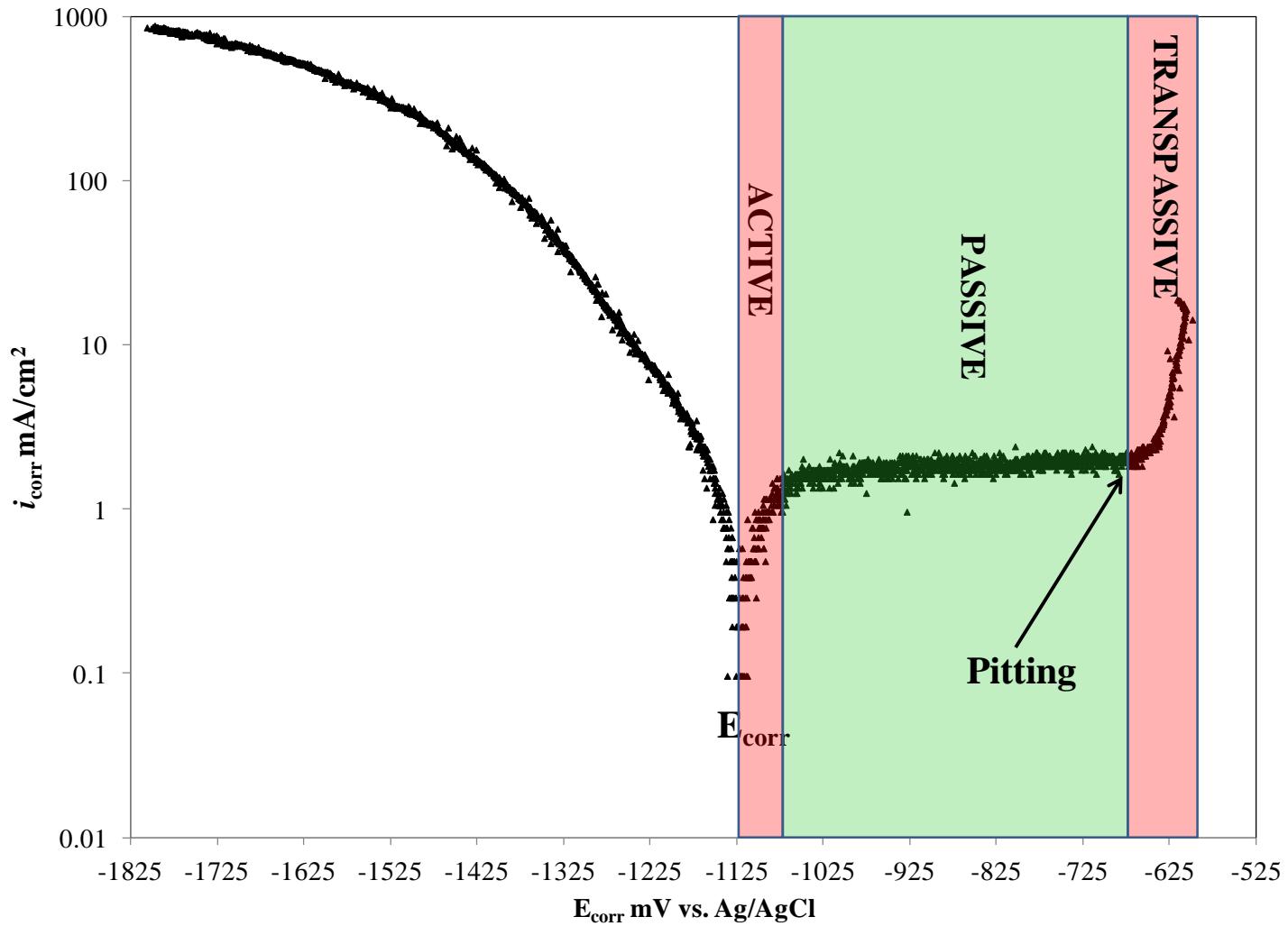


Polarization scan/AE



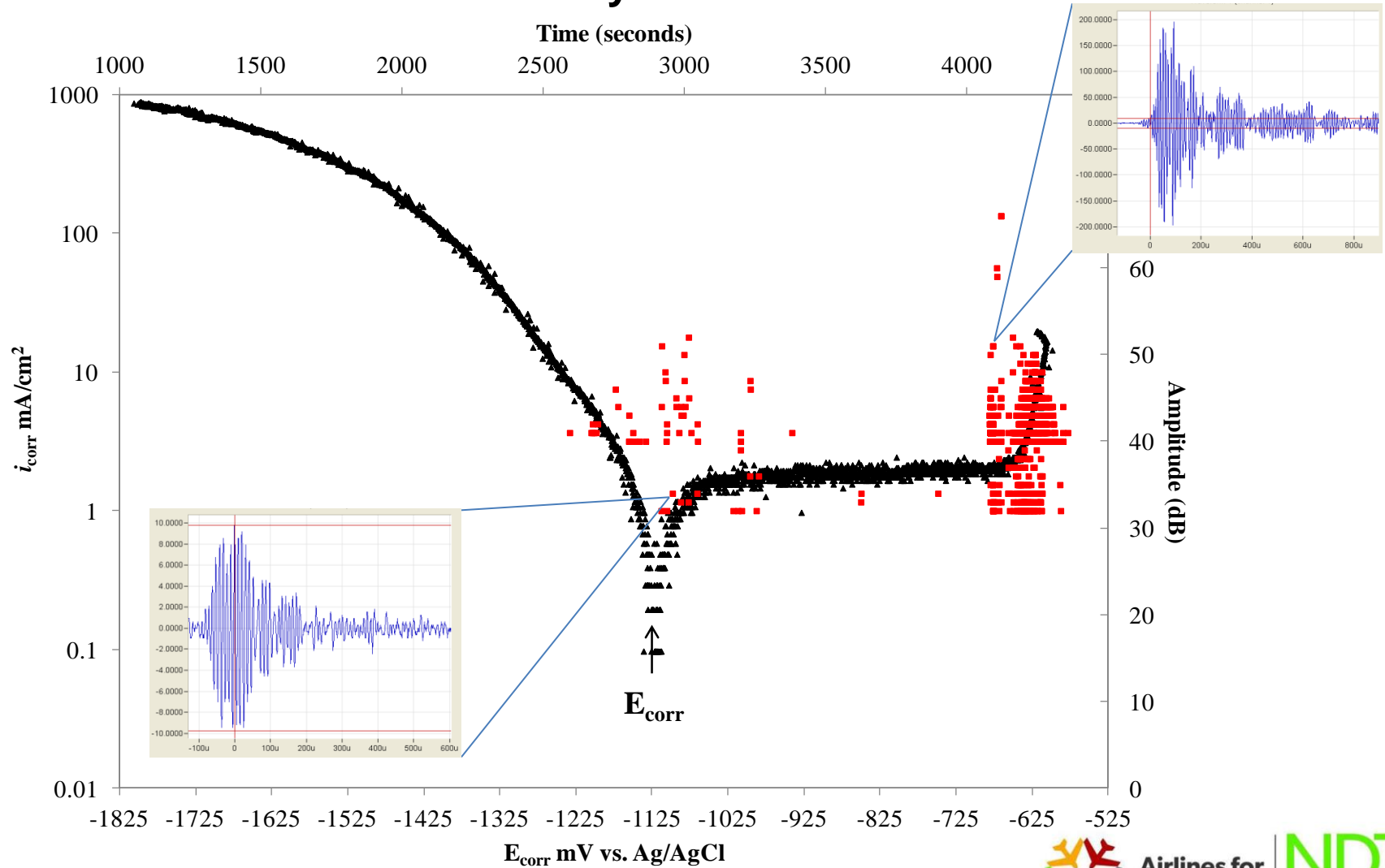
AE Pitting Corrosion Detection

Potentiodynamic scan/AE



AE Pitting Corrosion Detection

Potentiodynamic scan/AE



Corrosion Mechanism

Electrochemical corrosion occurs in two stages:

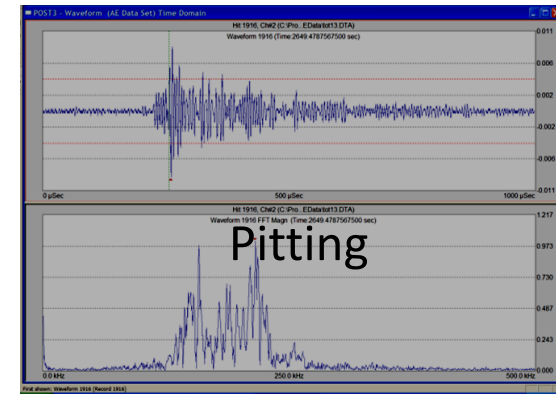
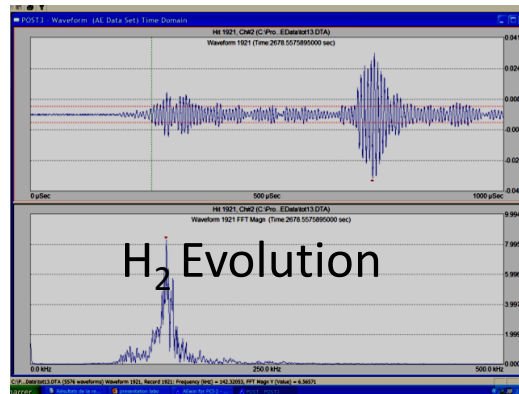
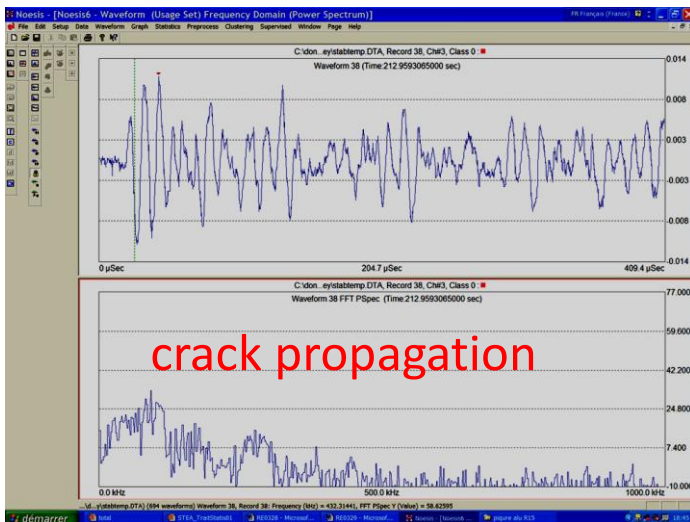
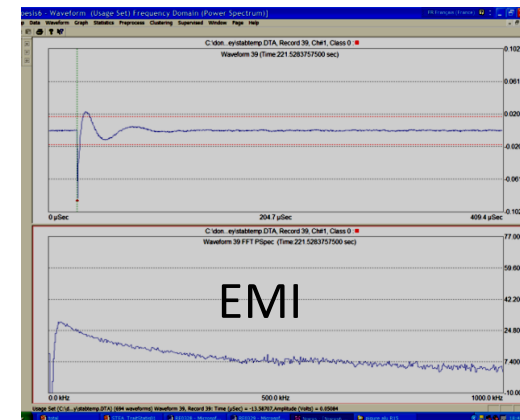
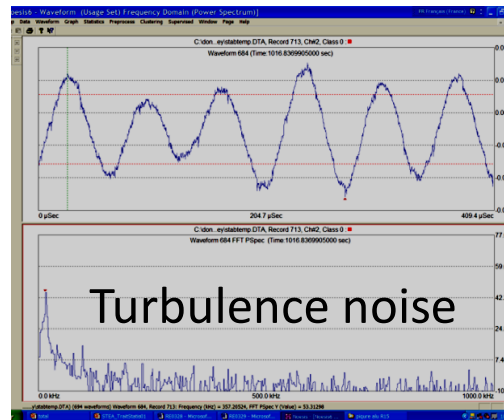
- Anodic dissolution of the metal and,
- Cathodic reduction of some species existing in the solution,
- On the cathodic sites of a metal surface close to the anodic zone on a single, whole metal surface.

ALL THE REACTIONS OCCUR ON THE SURFACE OF THE MATERIAL CORRODING.

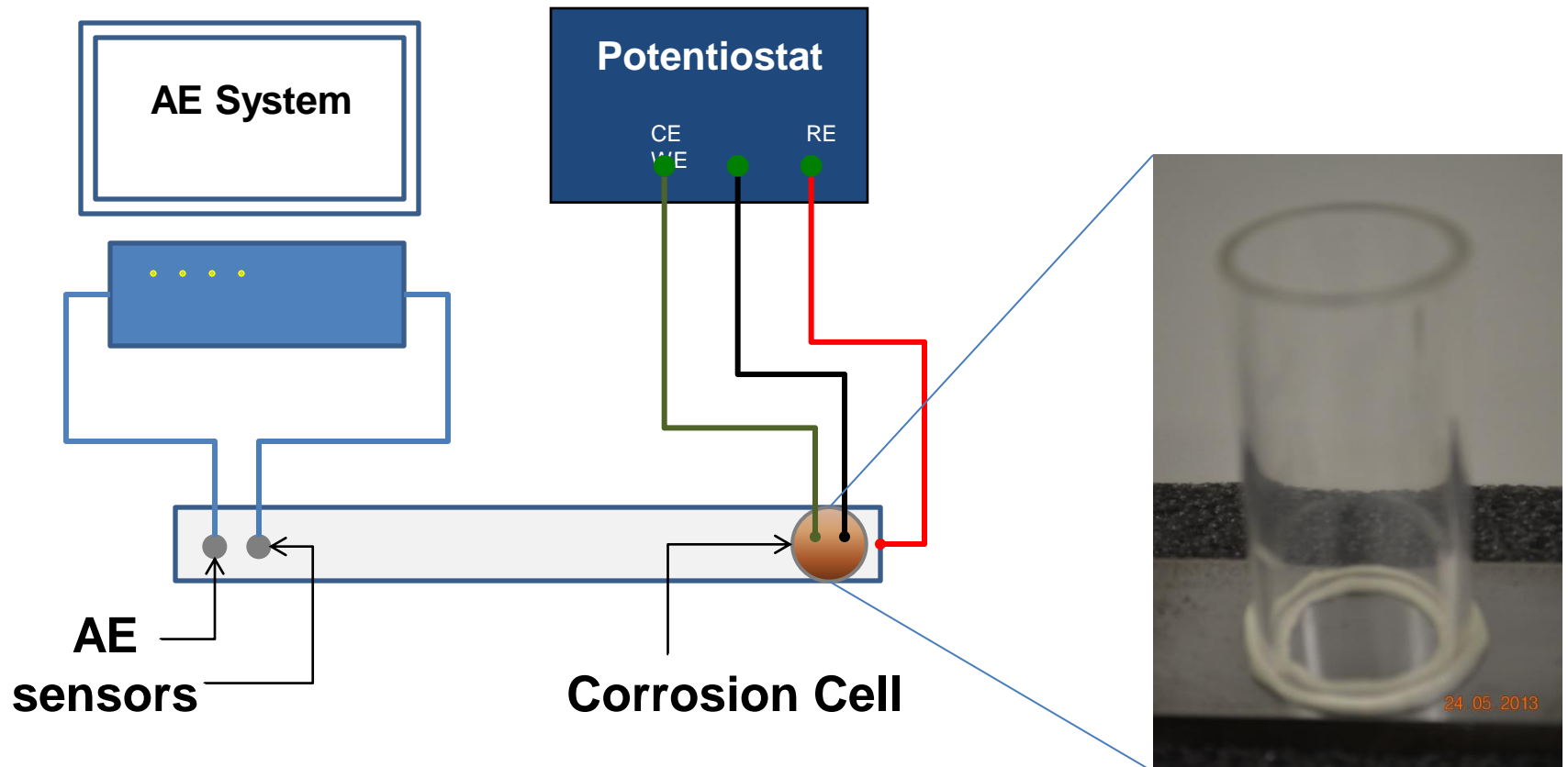
Example of different AE sources during Corrosion Monitoring

Need of pattern recognition analysis

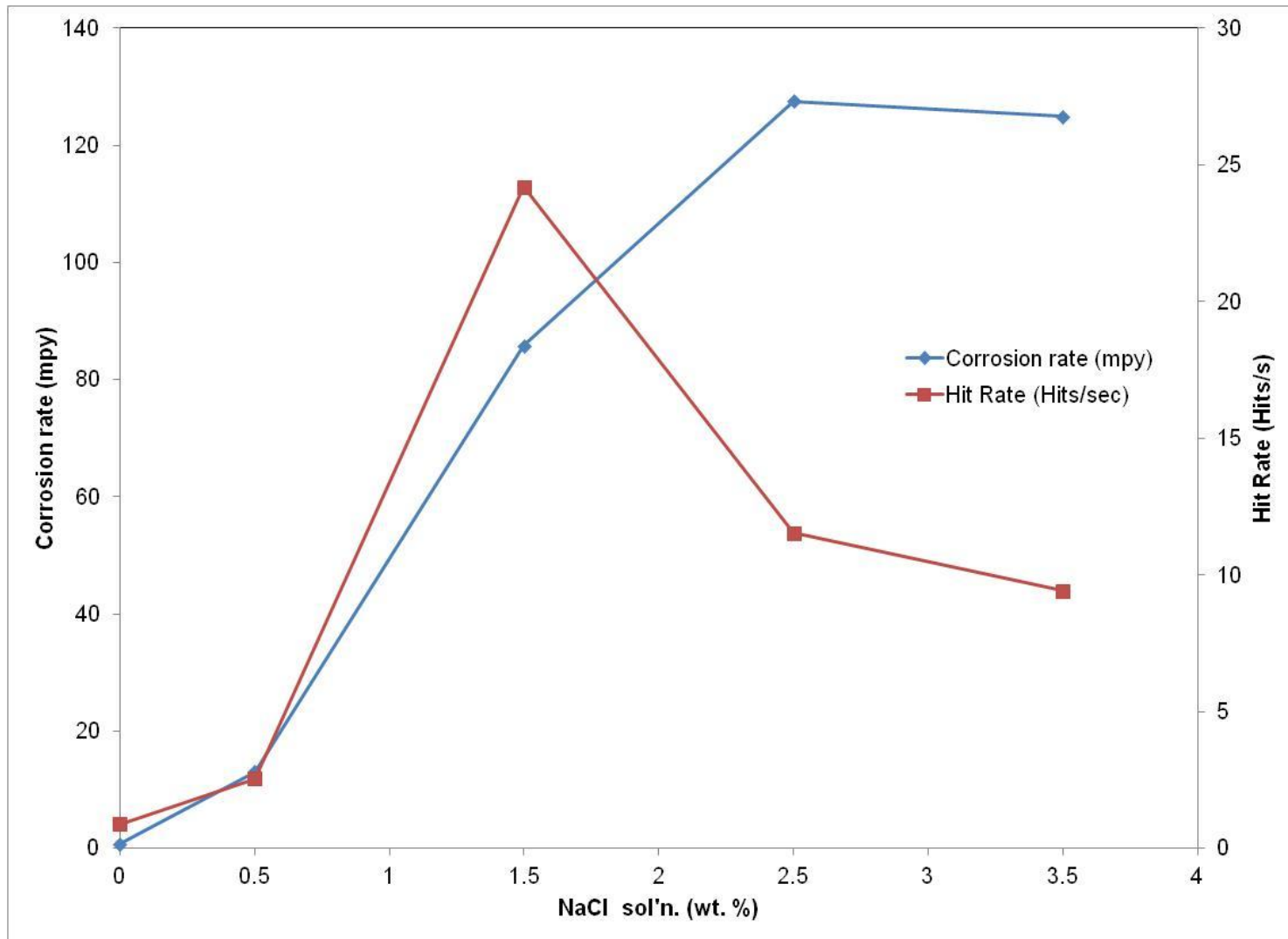
=> Data base



AE Measurements in Controlled Corrosion Experiments



AE Rate – i_{corr} vs. E Results



Airlines for
America

NDT
NONDESTRUCTIVE
TESTING FORUM

Preliminary Results

- During settlement of the corrosion cell and without any external perturbation to the corrosion cell, AE signals were easily detected with amplitudes above 40 dB.
- After settlement of the corrosion cell, a potential scan was carried out to identify different corrosion regions on Al alloy.
- Applied voltage and current were recorded, in order to correlate with AE activity.
- AE signals were detected at specific region of the polarization curve.

Preliminary Results

- AE signals related to cathodic reaction (water decomposition).
- AE signals detected around E_{corr} active region related to oxidation of Aluminum.
- AE signal detected at transition knee from passive to transpassive aluminum (breakdown of passive oxide).
- We are able to locate areas where damage is developing.

Future Work

- **Electrochemical Noise experiments in order to characterize the corrosion rates or localization index at different potentials.**
- **Correlation of AE features with corrosion rates.**

Conclusions

1. **Corrosion Can Be Detected with Acoustic Emission.**
2. **Good Agreement was Observed between the Corrosion Activity and Acoustic Emission Activity as a function of NaCl concentration.**
3. **Calculation of the Corrosion Rate and the AE Hit Rate, Showed a Strong Correlation between these Two Parameters.**
4. **AE Provides a Non Intrusive way to Measure Corrosion Activity.**
5. **Periodic Measurements at Regular Intervals will Allow to Take Action to :**
 - i. **Stop or Mitigate the Deterioration due to Corrosion**
 - ii. **Identify the Triggering Condition**
 - iii. **Validation of Protective Schemes are Effective**

Thank you for your interest

(609) 716-4080

E-mail: miguel.gonzalez@mistrasgroup.com