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Dynamic Environments Testing Focus Group

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IMAC XXXIX

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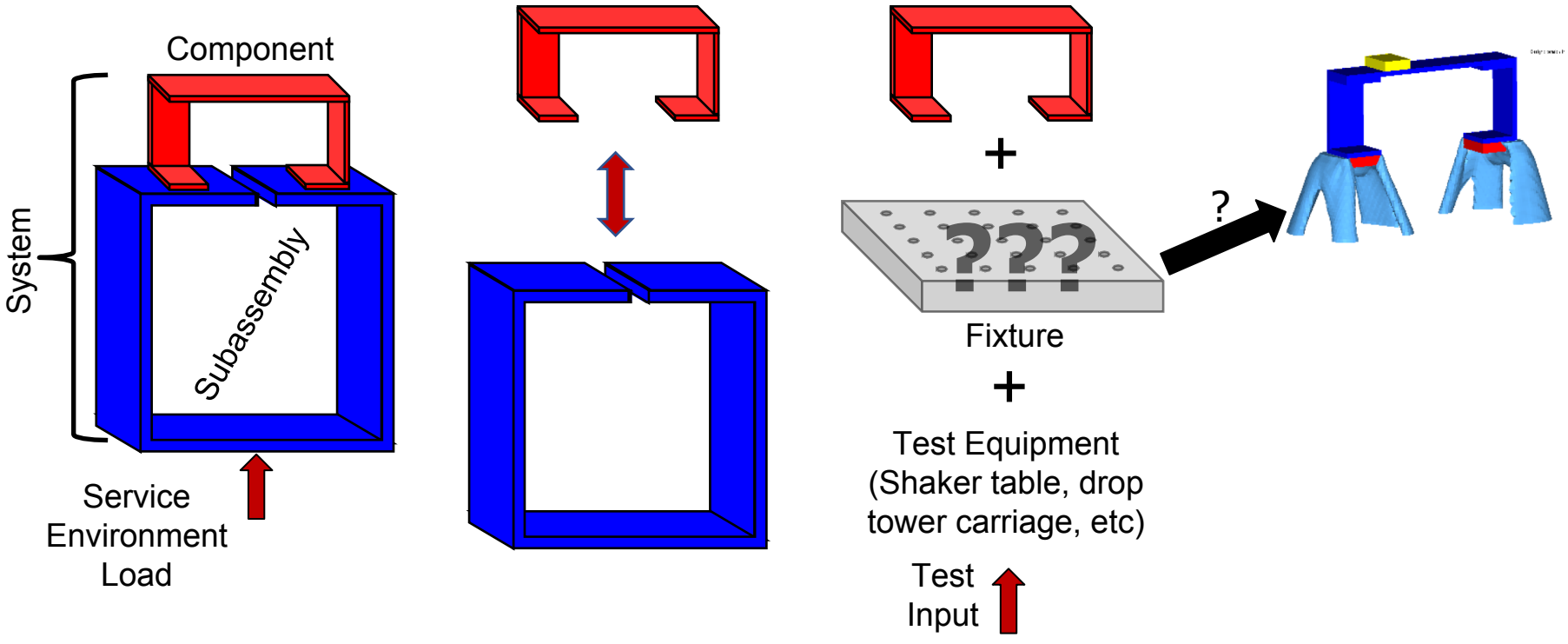
Agenda

- Sign up sheet / Introduction
- IMAC 39 Sessions
- IMAC 40 Sessions
- Boundary Condition Challenge Problem (Troy Skousen)
- Where we are in research (Tyler)
  - Environment specification
  - Boundary Condition
  - SDOF or MDOF load input
- Smart Dynamic Test Community of Practice (David Ewins)
- Combined Environment (Dan R)
- MIMO Spec Development (are people developing MIMO testing?) (Ryan)

DET Introduction

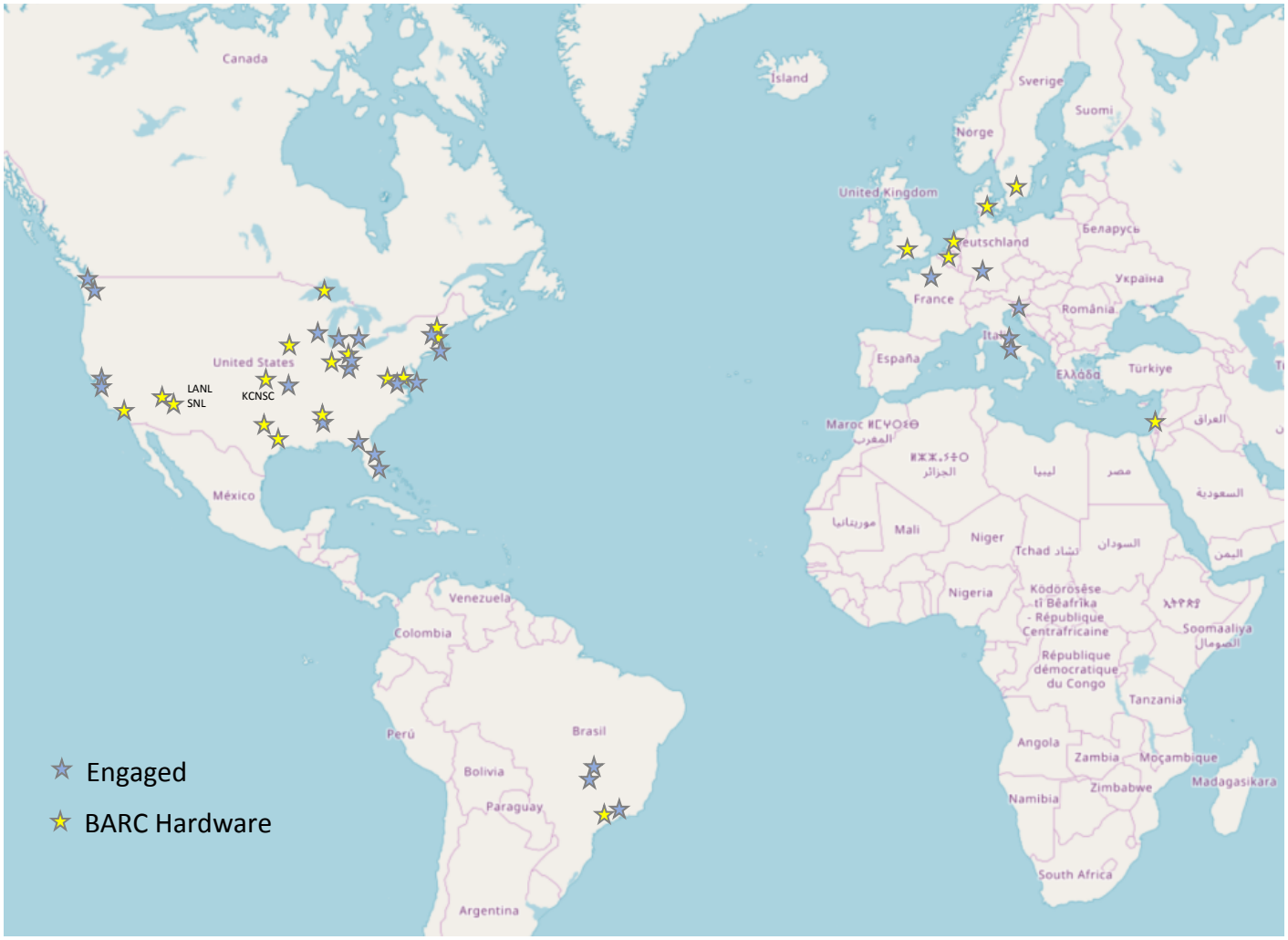
- Improve the process and fidelity of dynamic environments testing in the laboratory in order to better demonstrate how the unit of interest will respond in the operational environment of interest. The process of dynamic environments testing includes:
  - Specifying and characterizing the field environment to be represented in the laboratory (What to match/measure in test)
  - Developing a test fixture to attach to the unit of interest to provide proper boundary conditions (How to attach the unit)
  - Derivation of the loading and developing the method of imparting that load on the unit of interest (How to move the unit)

Boundary Condition Challenge Problem



Updated Challenge Problem Leadership			
Sandia National Laboratories		Kansas City National Security Campus	
Troy Skousen	Mechanical Environments Definition	Raymond Joshua	Analysis
Tyler Schoenherr	Structural Dynamic Analysis	Eric Dodgen	Analysis
David Soine	Shock Test		

Boundary Condition Challenge Problem



57 organizations

- 25 Commercial
- 21 Universities
- 5 NSE sites
- 5 DOD sites
- 1 NASA

14 countries

4 continents

Challenge Problem Discussion

- New SharePoint site hosted by Sandia (info in next Dynamic Environment Test newsletter)
- Lessons learned from the challenge problem
- What do people still want to do with the BARC and the current challenge problem?
- Do we need to change the BARC?
  - Were there issues with the design that got in the way of addressing the fundamental problem?
  - Does the fundamental problem need to be restated now that we have learned a bunch?
- If/When the time comes for another challenge problem, what should it look like?

Please contact Troy Skousen (tjskous@sandia.gov) if you have thoughts that we didn't have time to address in the meeting.

Where are we? (Non-Comprehensive List)

We Have

Test Specification	Boundary Condition	Excitation Strategy	Test Optimization
SDOF/MDOF specification methods at a point(s)	A way to characterize minimum error on a laboratory test	A way to derive inputs to a system with a rigid connection	
Force/Displacement Limiting Techniques	A method to determine if a rigid fixture is appropriate for a test	Methods to control multiple points on the unit for MDOF testing	

We Don't Have

Test Specification	Boundary Condition	Excitation Strategy	Test Optimization
A way to provide full field specification	A defined method/process to design a test fixture	Metrics for success to put in the control scheme	
Derive specifications for shock	Good understanding of the dynamics of a shaker/shock testers	Methods for controlling shock testing.	A common metric to compute the success of a test

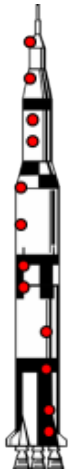
Discussion Question: How should we begin looking at combined environments?

- Example: Satellite on launch vehicle undergoes
  - Launch Acceleration (Centrifuge)
  - Launch Vibration (Shaker)
  - Separation Shock (Shock)
  - Temperature Changes (Thermal)
- Currently, tests are run sequentially, but this may not be accurate
  - E.g. Acceleration may change structure preloads, so vibration may be different in the presence of acceleration
- How can we begin addressing these combined test environments?
  - Large scale test capabilities
    - Vibrafuge – Vibration capability mounted on centrifuge
  - Smaller scale test capabilities
    - Modal shakers + Shaker table
    - Acoustic + Shaker table
    - Thermal + Shaker table or modal shakers
    - Piezoelectric Exciters
  - Controller capabilities
    - Multiple controllers run in parallel – sufficient?
    - Is there a way to synchronize existing control systems to make a test more repeatable?
    - Creation of a new “combined environments” control system?

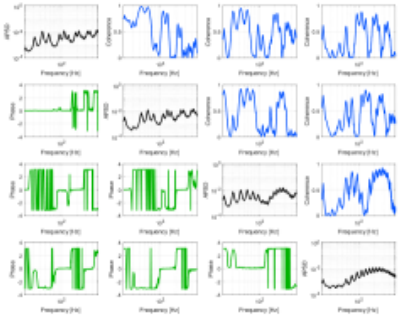
Discussion Question: How should we make and use specifications for MIMO?

- MIMO control needs spec as a CPSD matrix, S_{yy}
  - Multiple DOF – their levels (APSDs) and relationships (coherence & phase)
  - Best if S_{yy} is narrowband and representative of DUT dynamics (i.e. don't use band-averaged or enveloped specs)
- What are we currently doing?
  - Instrument a unit, subject it to field environment, derive a CPSD directly from time response – no specsmanship
  - Field test DOF are exactly the same as lab test DOF
- How do we make specs for MIMO?
  - Using "good specsmanship" – ensemble of tests, averaged together, with margin, uncertainty, etc.
  - May be band-averaged or enveloped, not exactly representative of DUT dynamics
- How do we make a spec we can use?
  - Mapping from the spec to what we give the controller
  - Mapping to/from different sets of DOF
- What techniques are others using?

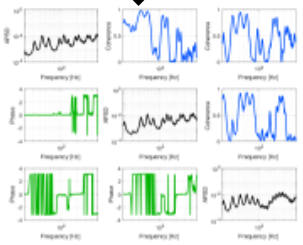
$$S_{xx} = H_{yx}^{+} S_{yy} H_{yx}^{+H}$$



Field Environment Test



What's this mapping process?



Lab MIMO Test