SAND2021-15784C

Benefits of Using a PCMM to Measure a Modal Test Geometry

Submission #: 12243

IMAC XL

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February 7-10, 2022

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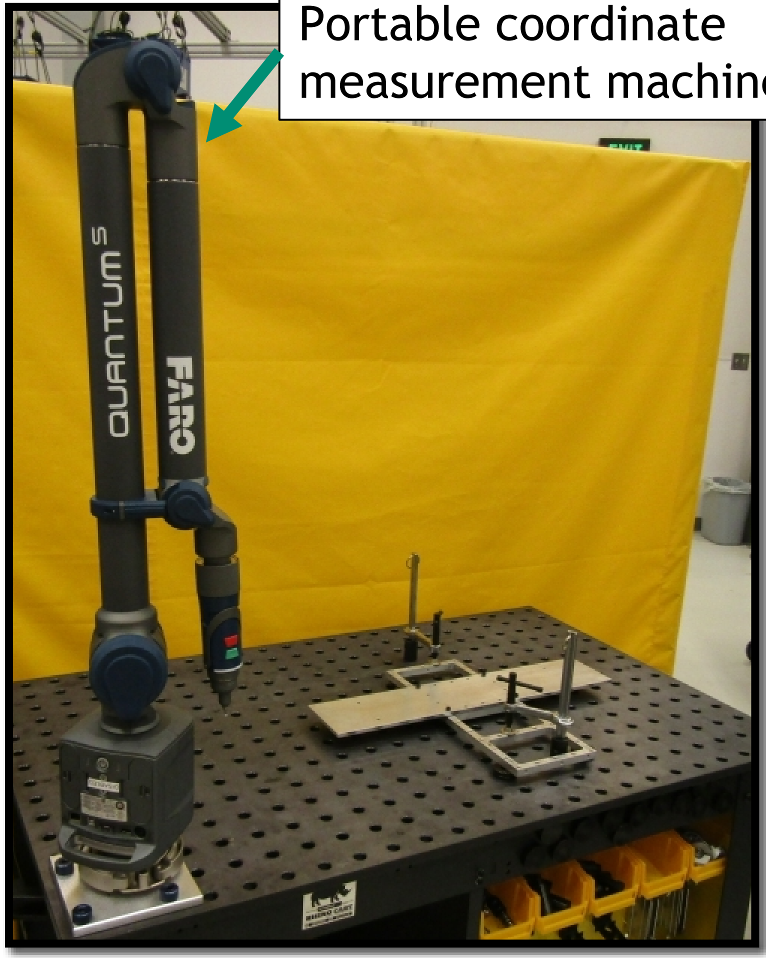
Introduction and Motivation

- Test geometries are critical for several aspects of modal analysis:
  - Mode shape visualization
  - Creating test-analysis models for FE model correlation
  - Communicating test set-ups

- Current methods leave a lot of room for improvement
  - Hand measurements are arduous
  - CAD based methods aren't always possible
  - Manual data entry is fraught with error

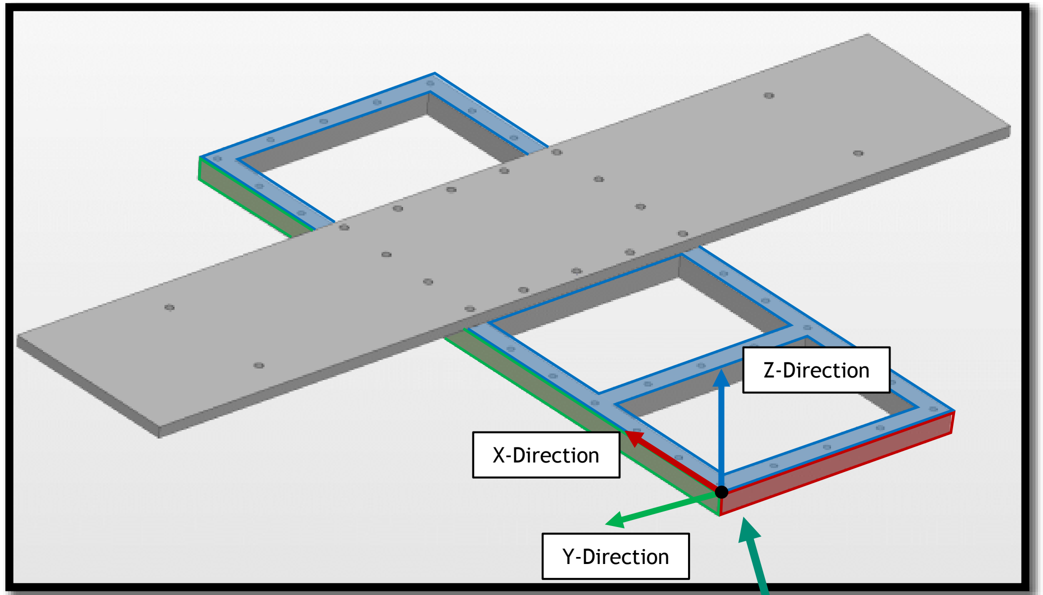
- A portable coordinate measurement machine (PCMM) based method is being suggested to largely automate the process to generate geometries



Measuring Accelerometer Locations with a PCMM

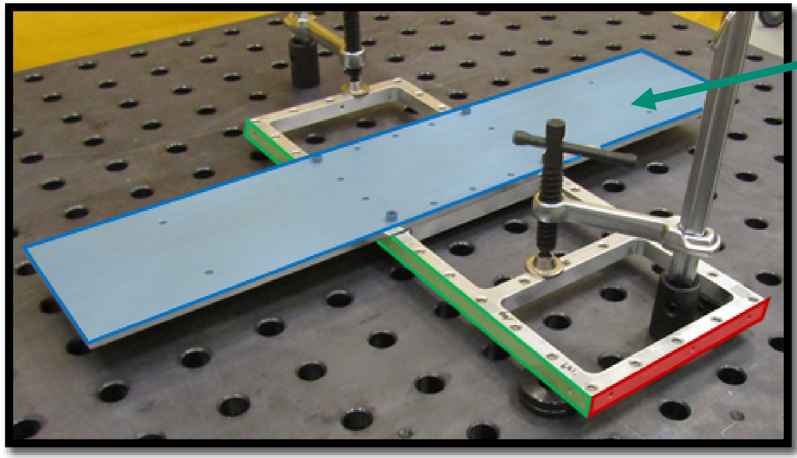
Defining the PCMM Coordinate System

Defining the Coordinate System with Reference Geometry from Probe Data



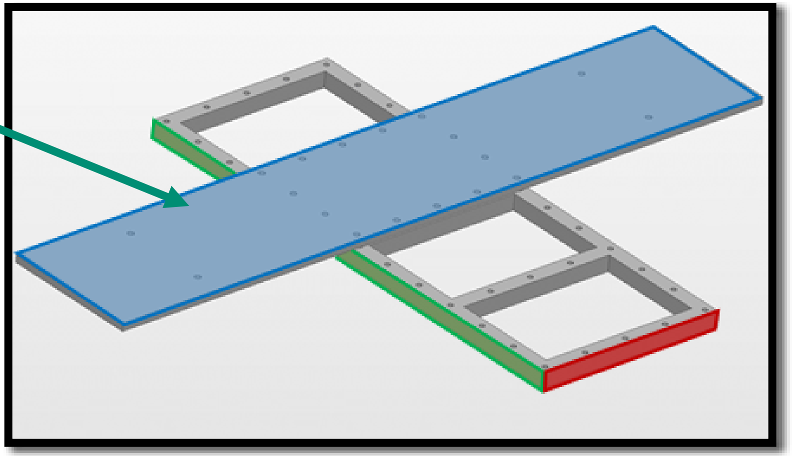
Planes being used as reference geometry

Aligning the PCMM to a CAD Model by Matching Reference Geometry



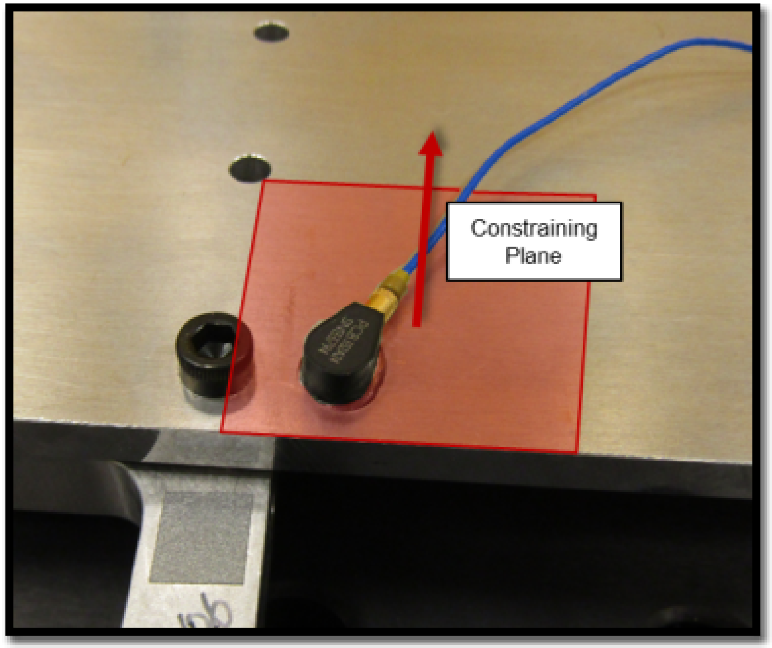
Probed plane representation

Planes picked on CAD model



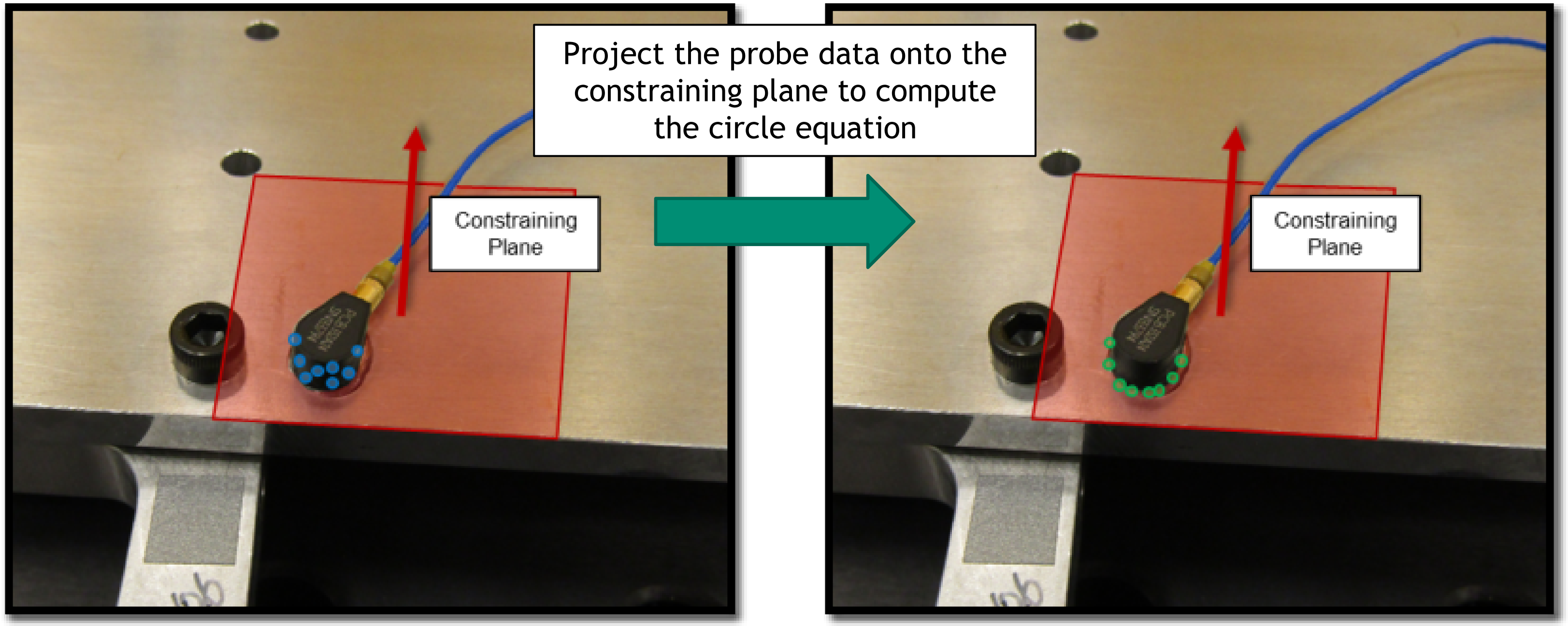
Measuring Uniaxial Accelerometer Locations and Orientations

Computing the Constraining Plane



The constraining plane defines the orientation of the accelerometer

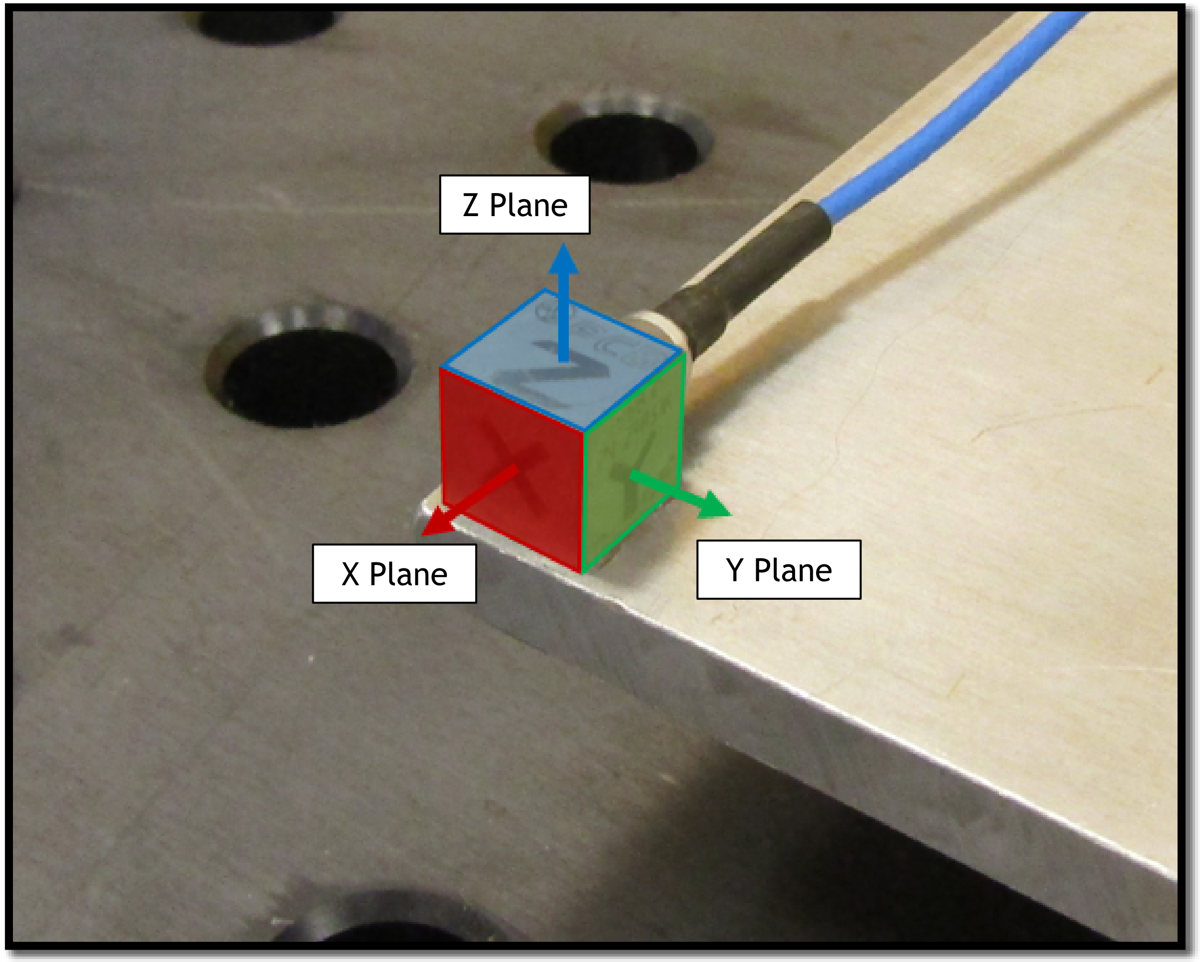
Computing the Equation of the Circle



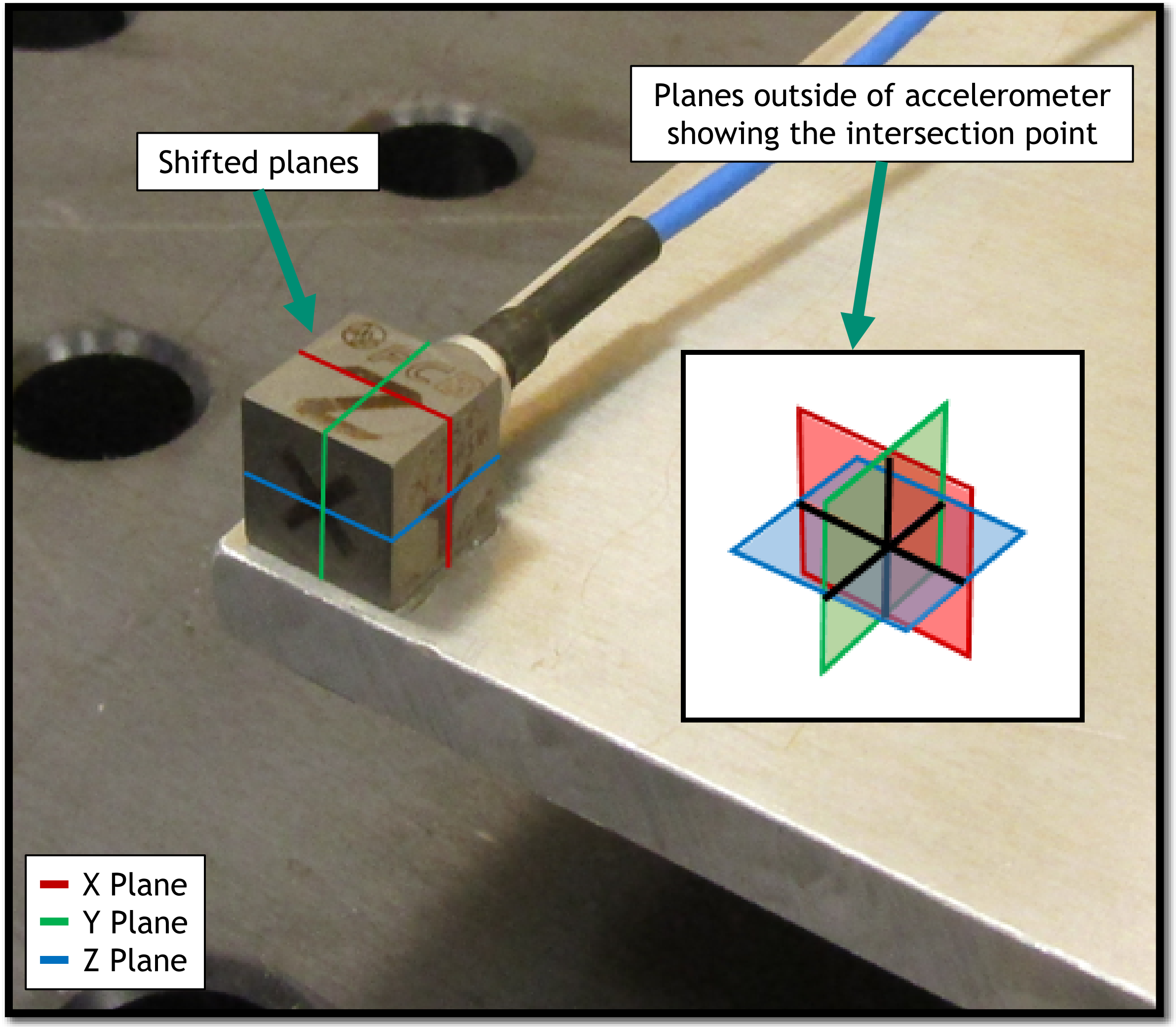
The center of the circle defines the location of the accelerometer

Measuring Triaxial Accelerometer Locations and Orientations

Computing Plane Equations



Shifting the Planes to Determine the Centroid



Notes on Automation and Data Validation

- Efforts were made to automate as many tasks as possible – *this is enabled by standardized data formats and naming conventions*

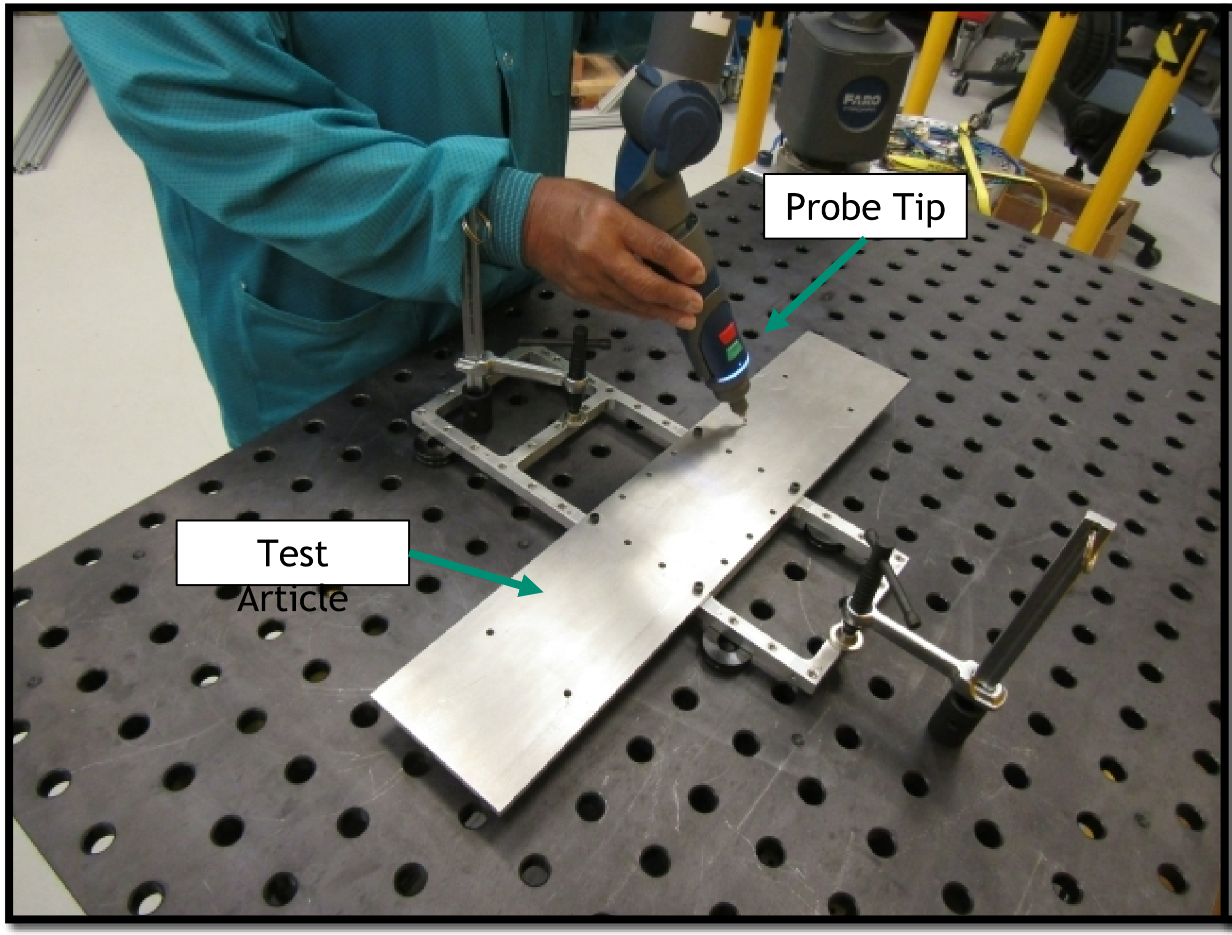
- There are several data validation features in the process, including:
  - Verify sufficient probe data quality
  - Verify that all the nodes follow the right hand rule
  - Check that the bounding box for the geometry matches expectations

The geometry generation process was designed to be highly automated and include several data validation features

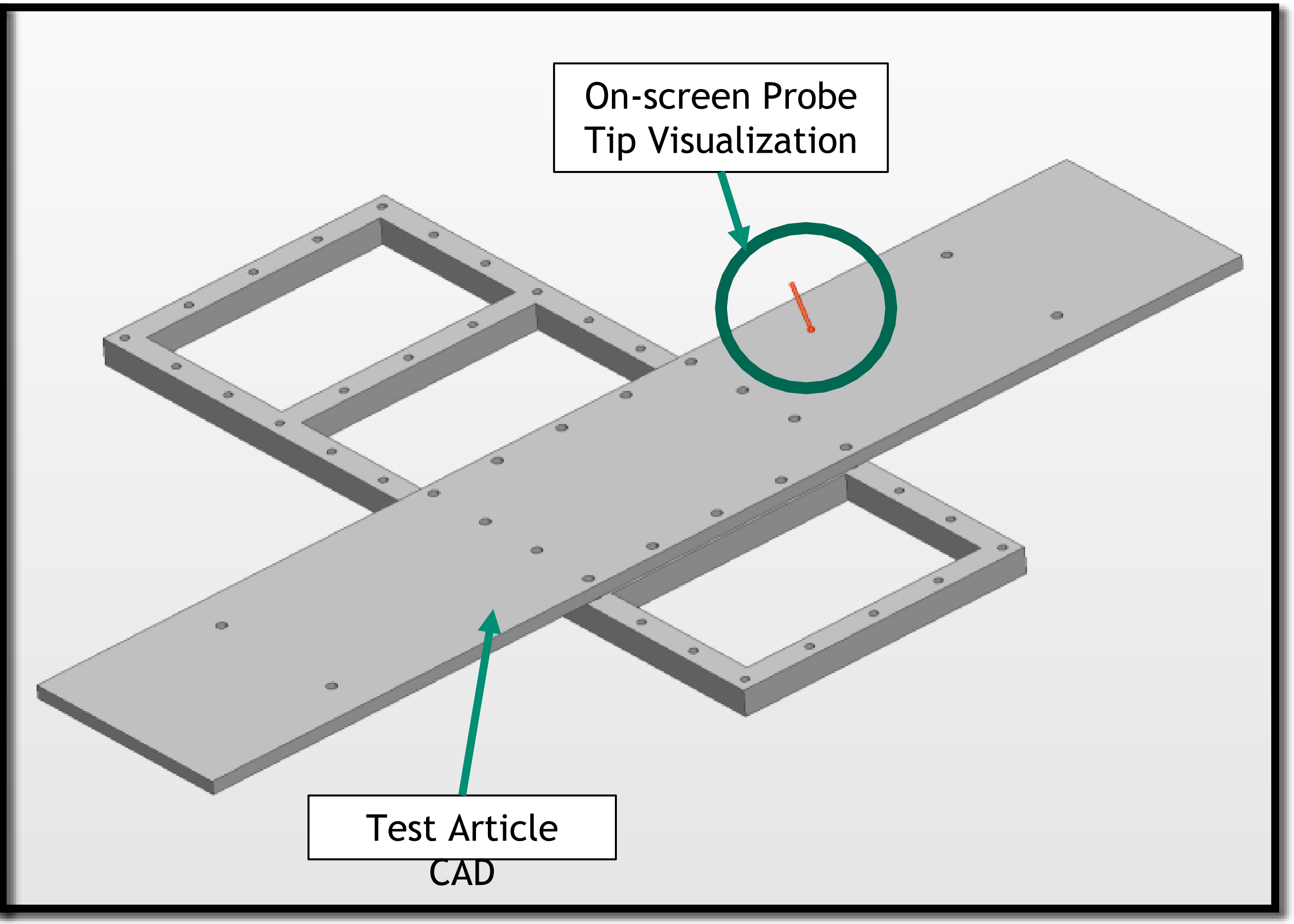
Identifying Specified Accelerometer Locations

On-screen Probe Tip Visualization

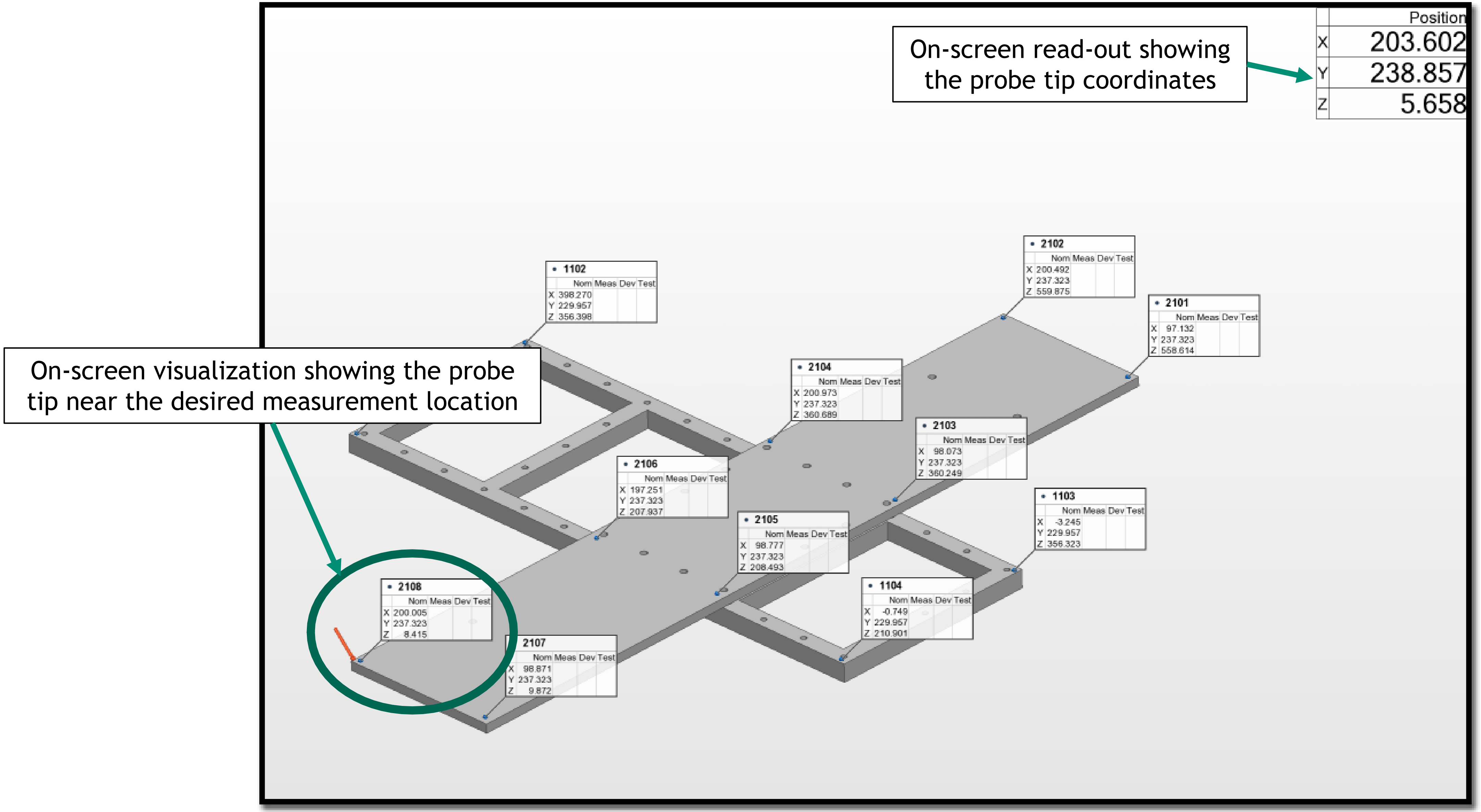
Physical PCMM Measurement Set-up



PCMM Software On-screen Visualization



Using the On-screen Visualization to find Measurement Locations



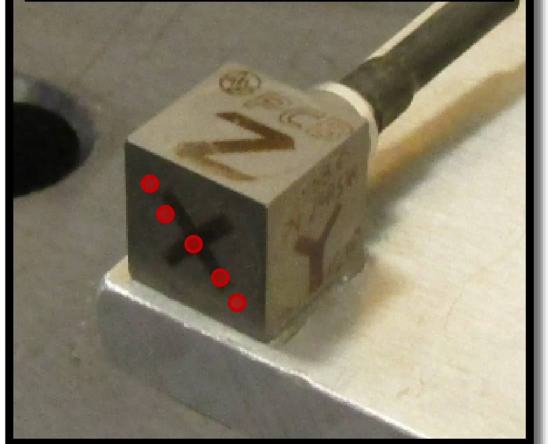
Discussion of the Method

Comments on Accuracy

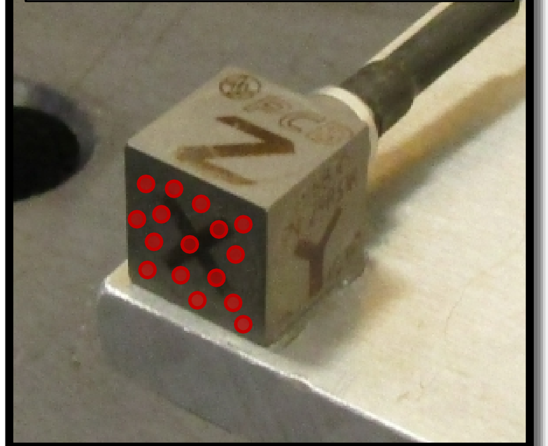
- It is difficult and unnecessary to achieve the full accuracy of the PCMM (0.0008” or 0.02 mm), several sources of error exist:
  - Contact with the part causes small movements
  - Errors from device moves
  - Computational methods introduce errors
- Rigid fixturing for the PCMM and test article is critical
- Reduced accuracy requirements lead to easier measurements
- It is important to focus on collecting data that can be easily processed into the desired geometry types

How accurate does the geometry need to be?

Poorly Defined Plane



Well Defined Plane



Benefits of Using the PCMM to Measure Test Geometries

The accuracy and automation of the method makes the test set-up process significantly faster and easier

- **Speed** – the PCMM process reduces geometry development process from several days to a few hours
- **Reliability** – the PCMM process makes it easier to trouble mode shape visualization issues, since the geometry is rarely at fault
- **Ease of Test Set-up** – the PCMM process automates the documentation process for accelerometer orientation, eliminating a major step in the test set-up process
- **Using Geometries for Test Documentation** – the ease and speed of the PCMM process make it feasible to use test geometries for documentation on test types at don't require a geometry (flight test, RLDA, etc.), instead of just pictures

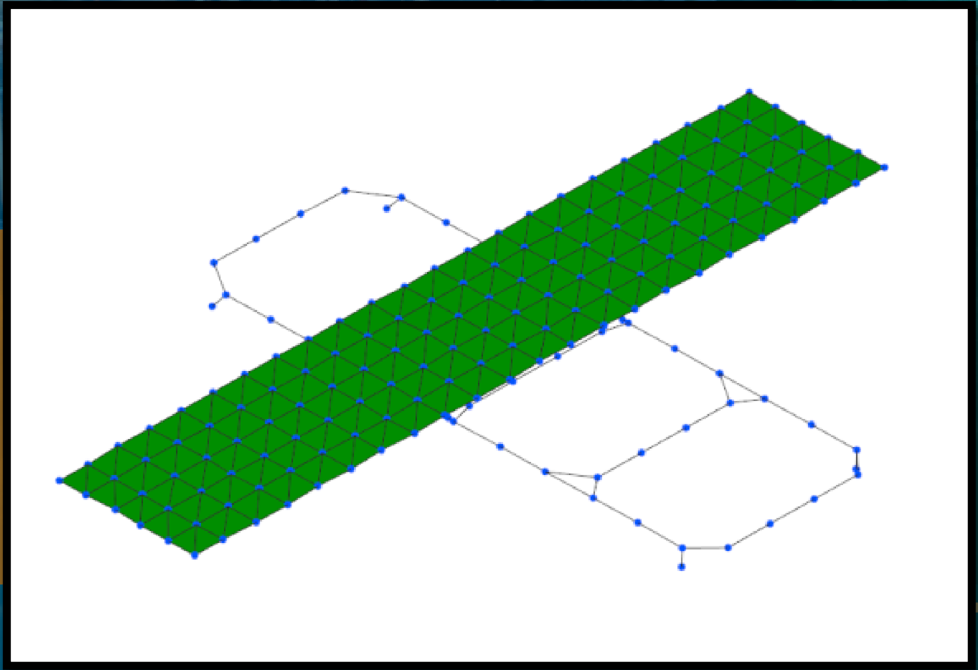
Conclusions and Suggestions for Future Work

- The PCMM process provides significant advantages in the geometry generation process when compared to standard methods

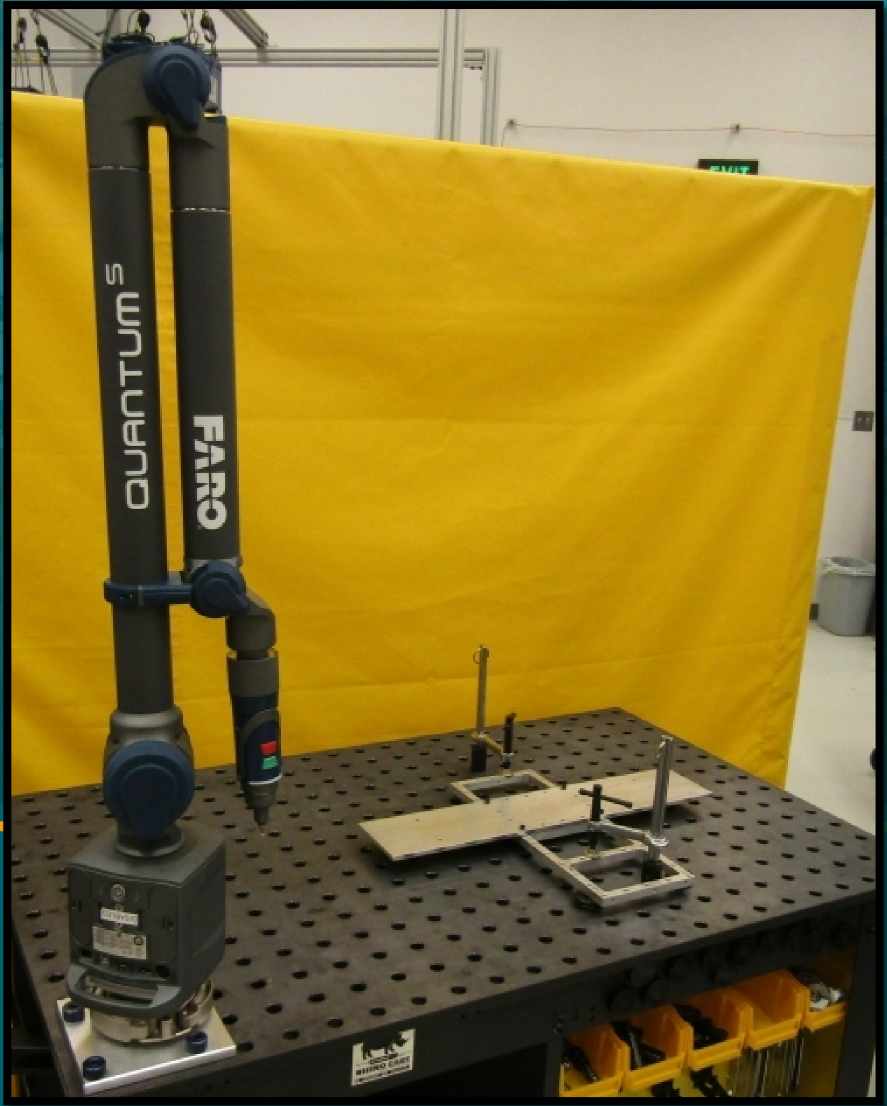
- The speed advantages in the PCMM process may justify the high initial investment

- Future work could improve upon this method by using non contacting measurement techniques

- Objective comparisons between the PCMM process and standard methods could lead to better application of the various geometry generation methods



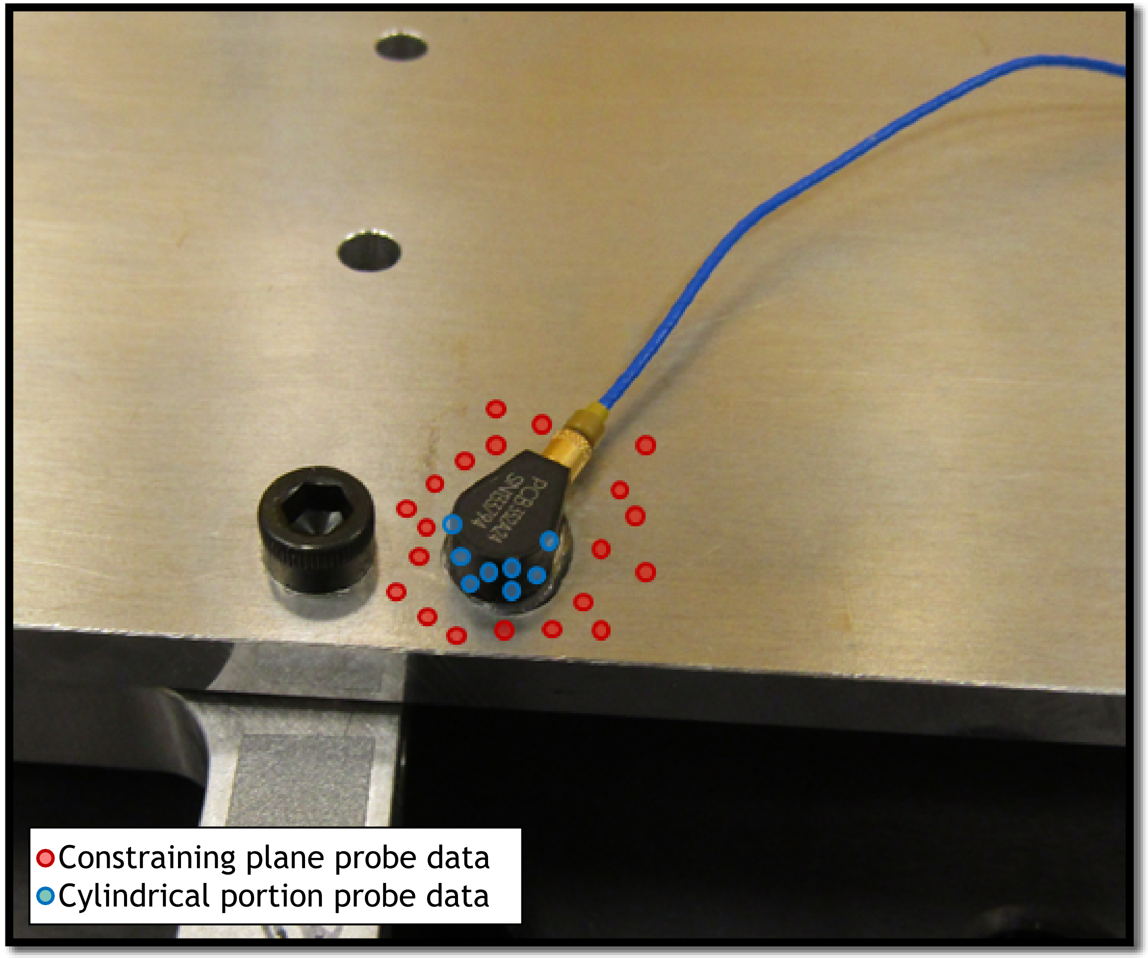
Thank You!



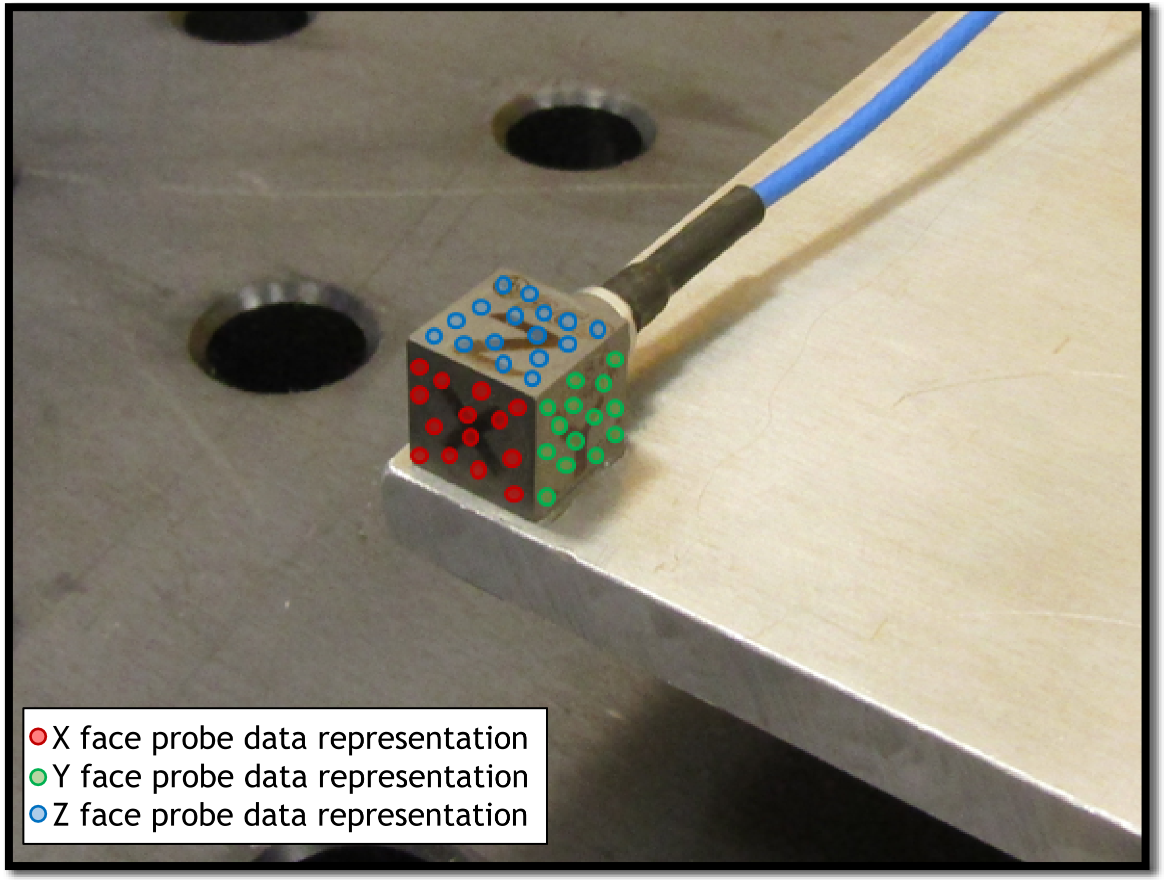
Back-up

2. Collect Probe Data

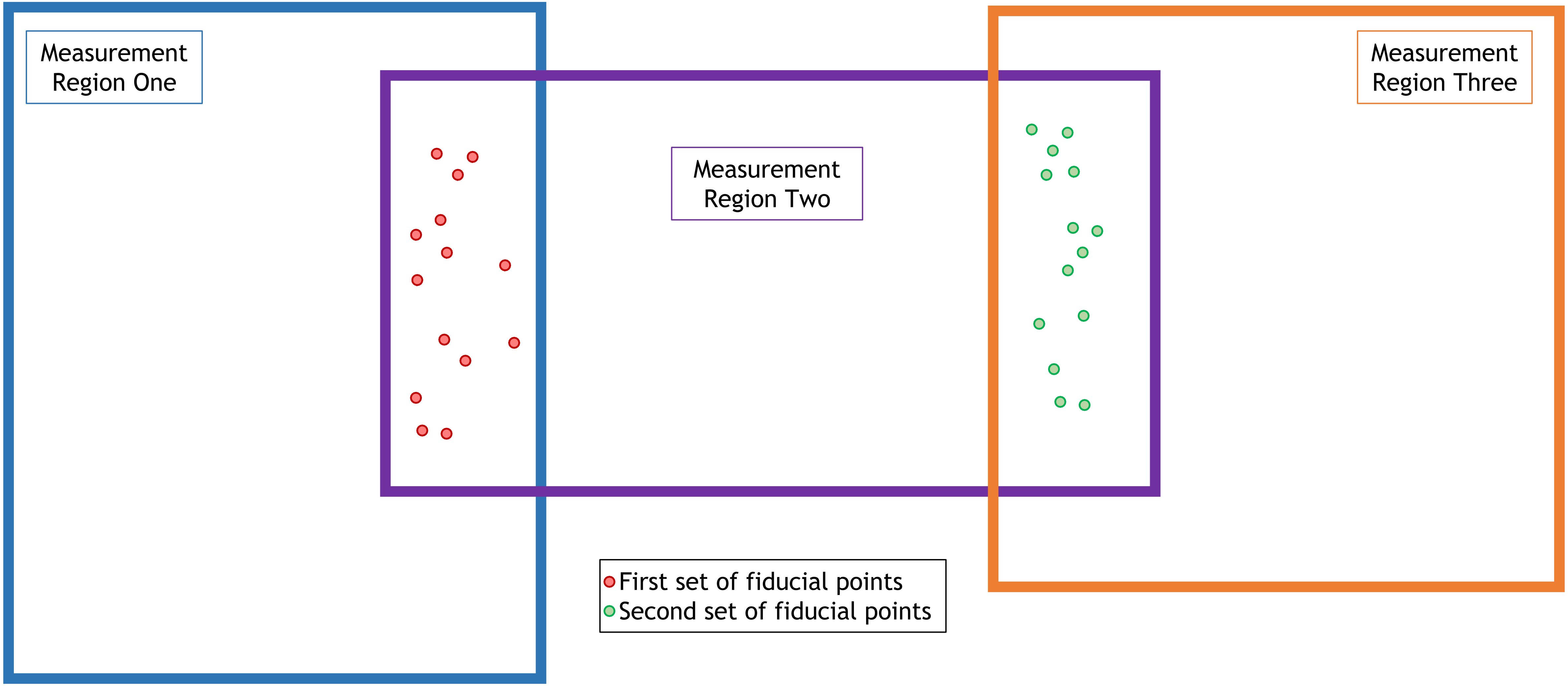
Example Probe Data for a Uniaxial Accelerometer



Example Probe Data for a Triaxial Acclerometer



Measuring Probe Data on Large Structures



Probe data is measured on large structures by using fiducial points and “device moves”

Adding Measurement Locations to the CAD Model Representation