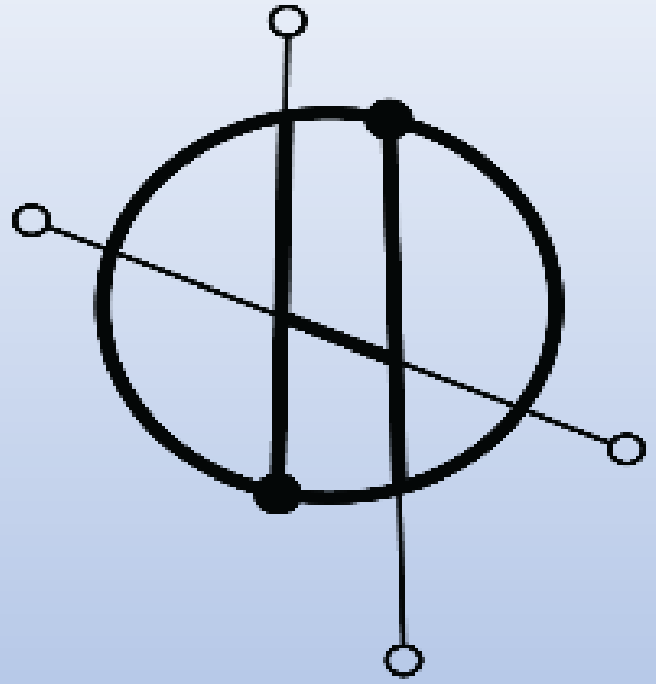
RAFFAELE PIAZZOLLA

IAPS-INAF



P/L QUALIFICATION CAMPAIGN - VIBRATION (PRELIMINARY)

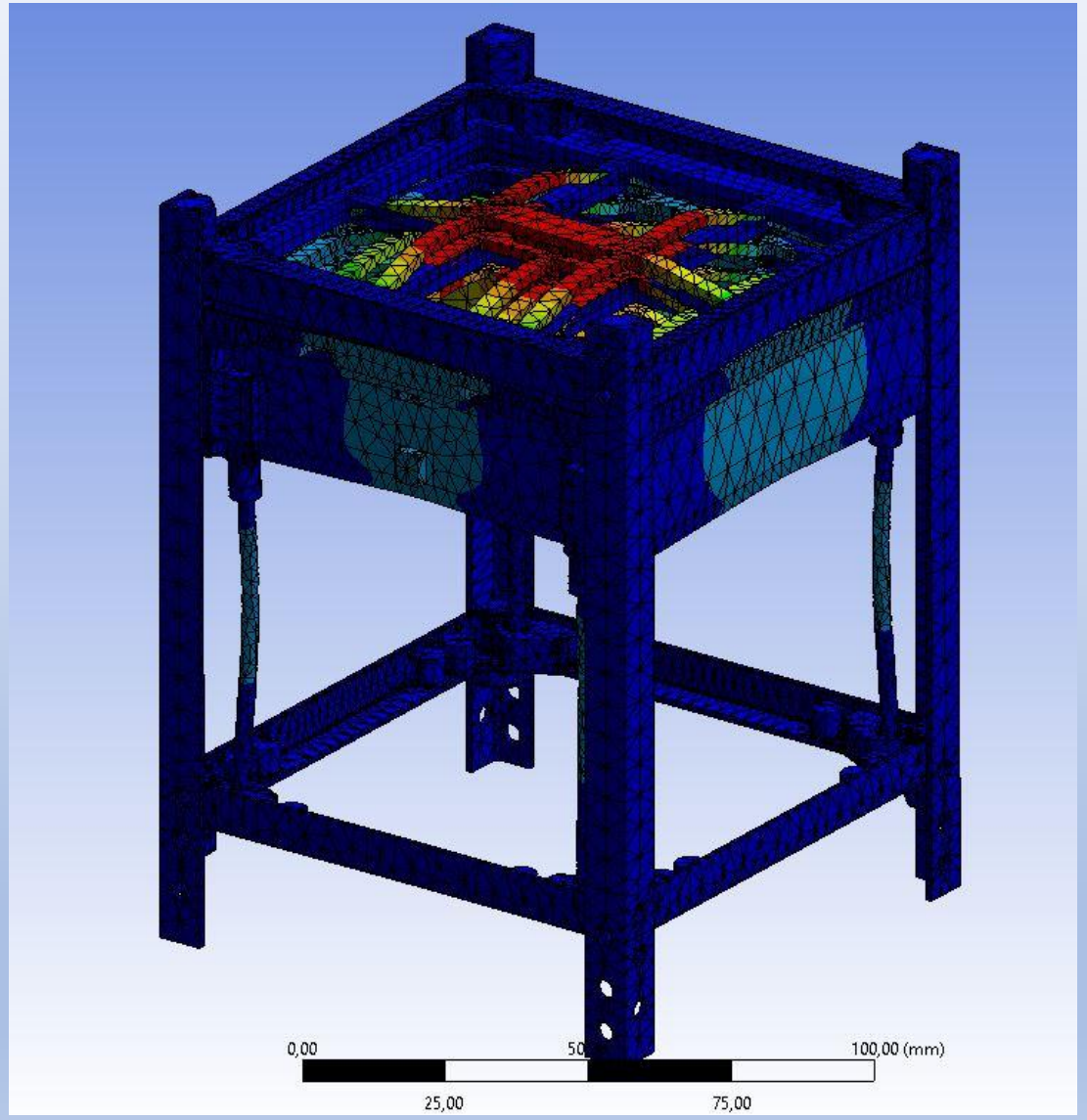
22-23 JAN 2020

OVERVIEW

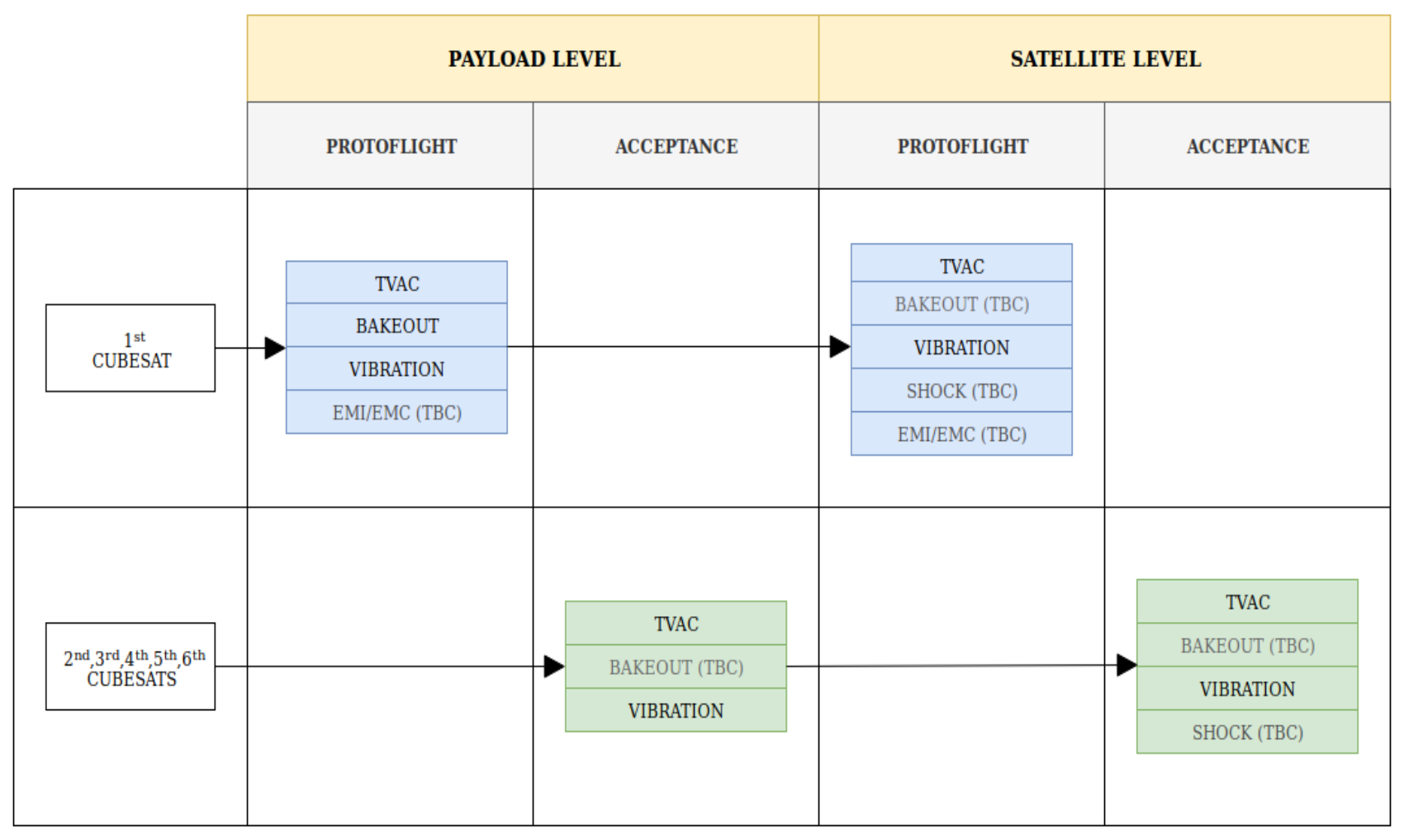
1) PFM APPROACH

2) TEST PLAN DEFINITION

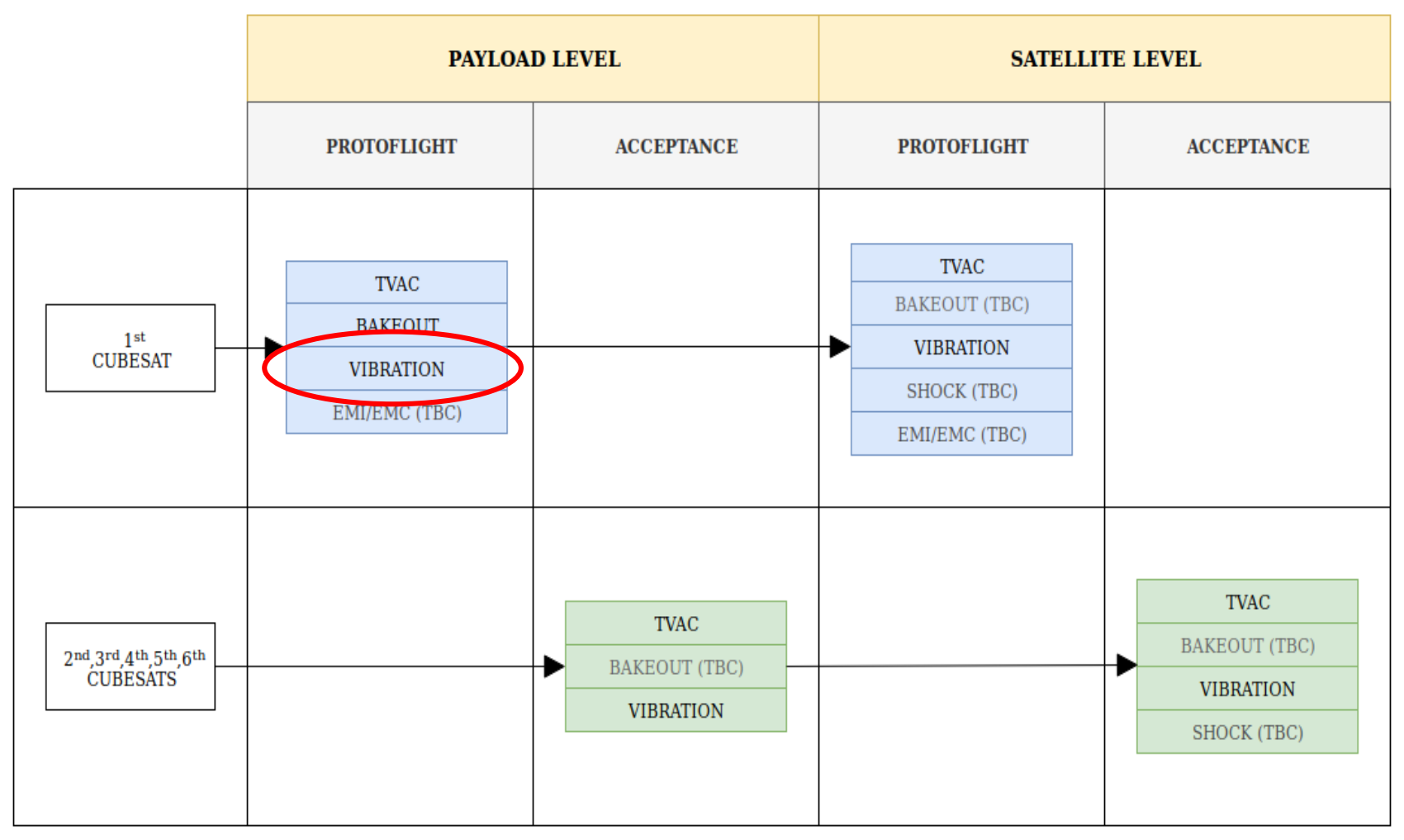
3) OPEN POINTS



PROTOFLIGHT MODEL APPROACH to TEST



PROTOFLIGHT MODEL APPROACH to TEST



PROTOFLIGHT TESTING

ECSS-E-ST-10-03C – Space Engineering - TESTING

PFM testing shall be performed on the first FM:

- to provide evidence that the space segment element or equipment performs in accordance with the specifications in the intended environments with the specified qualification margins
- to confirm its readiness for delivery and subsequent usage, being free from workmanship defects and flawed materials.

Test conditions shall be established using predicted environment plus margins.

MECHANICAL TEST	LEVELS	DURATION	CHECK	NOTE
PHYSICAL PROPERTIES (MASS, CoG & MoI)				CALCULATED
STATIC LOAD				NOT REQUIRED
ACOUSTIC				NOT REQUIRED
RANDOM VIBRATION	MAXIMUM EXPECTED SPECTRUM +3 dB on PSD VALUES	1 MINUTE PER EACH ORTHOGONAL AXES	FUNCTIONAL TEST / DETAILED VISUAL CHECK	RESONANCE SEARCH PRE & POST
SINUSOIDAL VIBRATION	1.25 X LIMIT LOAD SPECTRUM	SWEEP AT 4 Oct/min, 5Hz – 100 Hz PER EACH ORTHOGONAL AXES	DETAILED VISUAL CHECK	RESONANCE SEARCH PRE & POST
SHOCK	MAXIMUM EXPECTED SHOCK SPECTRUM +3 dB MARGIN	20 – 30 ms 1 TEST	DETAILED VISUAL CHECK HARDWARE INTEGRITY	PERFORMED FOR SHOCK CRITICAL ELEMENTS

PROTOFLIGHT TEST LEVELS

ACCEPTANCE TESTING

ECSS-E-ST-10-03C – Space Engineering - TESTING

Acceptance testing shall be performed on each FM:

- to provide evidence that the space segment element or equipment performs in accordance with the specifications in the intended environments with the specified acceptance margins
- to confirm its readiness for delivery and subsequent usage, being free from workmanship defects and flawed materials.

Test conditions shall be established using predicted environment plus margins.

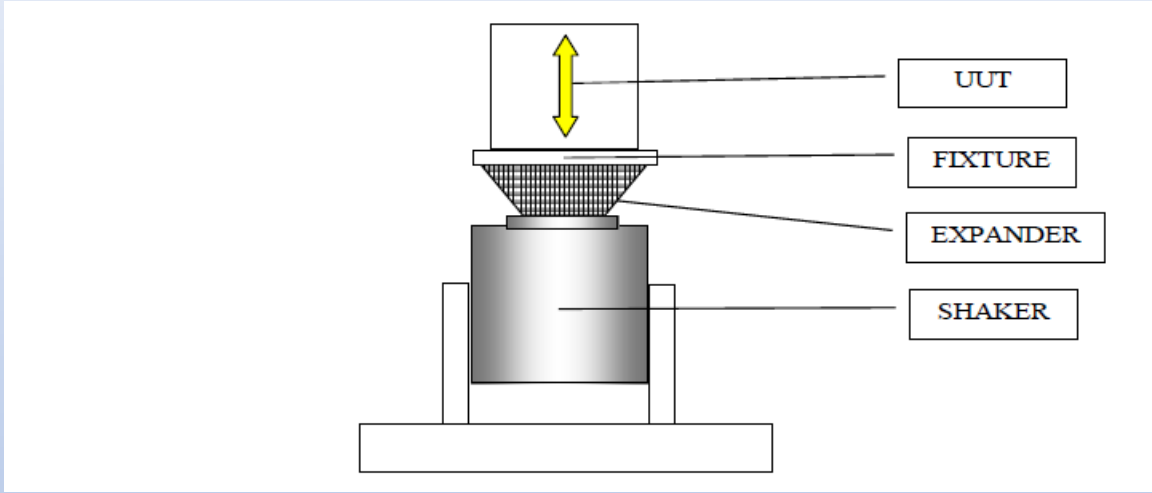
MECHANICAL TEST	LEVELS	DURATION	CHECK	NOTE
PHYSICAL PROPERTIES (MASS, CoG & MoI)				CALCULATED
STATIC LOAD				NOT REQUIRED
ACOUSTIC				NOT REQUIRED
RANDOM VIBRATION	MAXIMUM EXPECTED SPECTRUM +0 dB on PSD VALUES	1 MINUTE PER EACH ORTHOGONAL AXES	FUNCTIONAL TEST / DETAILED VISUAL CHECK	RESONANCE SEARCH PRE & POST
SINUSOIDAL VIBRATION	1 X LIMIT LOAD SPECTRUM	SWEEP AT 4 Oct/min, 5Hz – 100 Hz PER EACH ORTHOGONAL AXES	DETAILED VISUAL CHECK	RESONANCE SEARCH PRE & POST
SHOCK				NOT REQUIRED

ACCEPTANCE TEST LEVELS

TO PERFORM VIBRATION TESTING, MUST BE DEFINED:

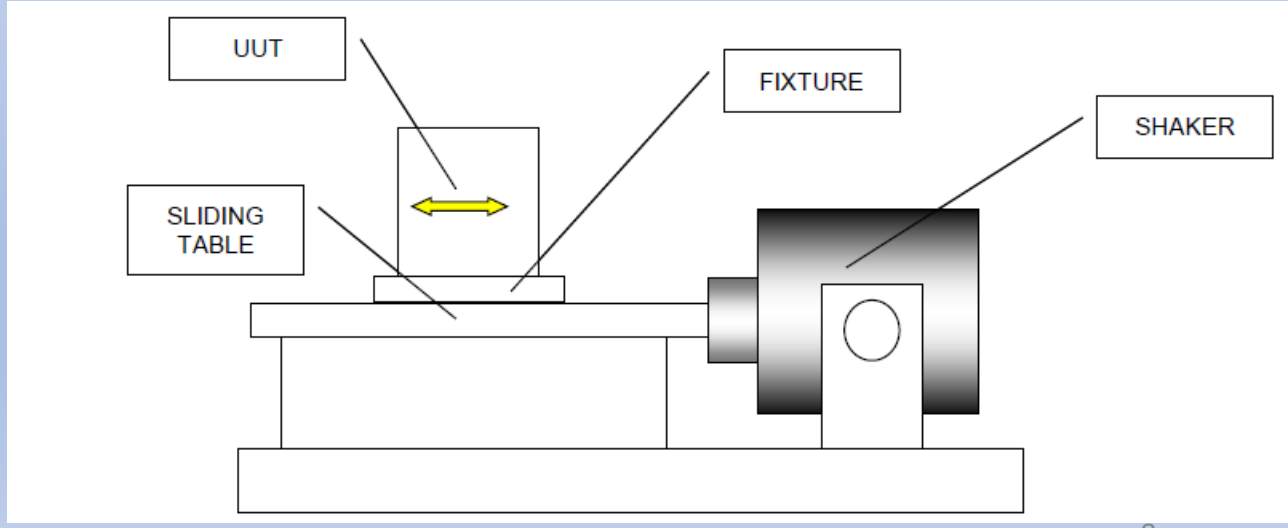
TEST CONDITIONS	TEMPERATURE, RELATIVE HUMIDITY, PRESSURE, CLEANLINESS OF TEST FACILITY
TEST TOLERANCES	INPUT LEVELS TOLERANCES
TEST ACCURACY	OUTPUT MEASURED ACCURACIES
REQUIREMENTS	SURVIVE PF LEVEL RANDOM VIBRATION ENVIRONMENT, NO RESONANCE BELOW 100 Hz
INSTRUMENTATION PLAN	MEASUREMENT POINTS POSITION, REFERENCE FRAME
SUCCESS CRITERIA	NO DAMAGE, NO RESONANT FREQ. BELOW 100 Hz, NO RELEVANT DIFFERENCES IN RECORDED SINE RESONANCE SEARCH, ETC.
INPUT LEVELS	DEPENDANT ON LAUNCH VEHICLE, INTERFACE, ORIENTATION, C/S DEPLOYER, ETC.
TEST PREDICTION	MODAL & RANDOM VIBRATION FEM ANALYSIS -> NOTCHING
TEST CONFIGURATION	EXCITATION DIRECTION (IN-PLANE, OUT-OF-PLANE), GSE AND TEST TOOLS (FIXTURE)
TEST STRATEGY	TEST SEQUENCE (RESONANCE SEARCH, SINE VIBE, RES.SEARCH, RANDOM LOW LEVEL ETC.
TEST PROCEDURE	STEP-BY-STEP DETAILED PROCEDURE

TEST CONFIGURATION

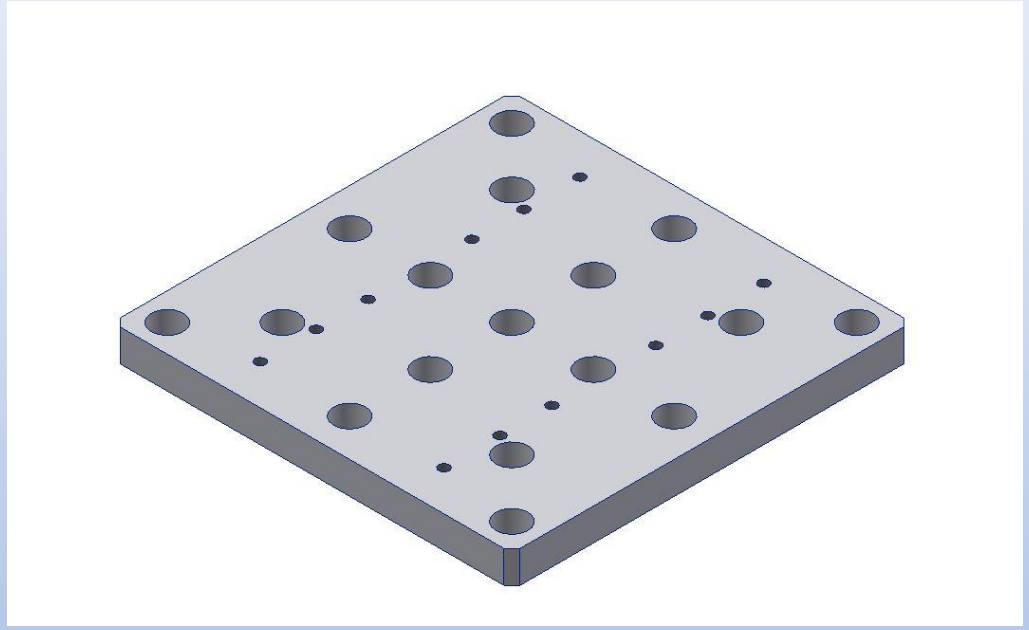


For **out-of-plane input excitation** (Z axis), the fixture and the UUT will be mounted on the shaker head expander.

For **in-plane input excitation** (X, Y axes), the fixture and the UUT will be mounted on the slip table connected to the shaker



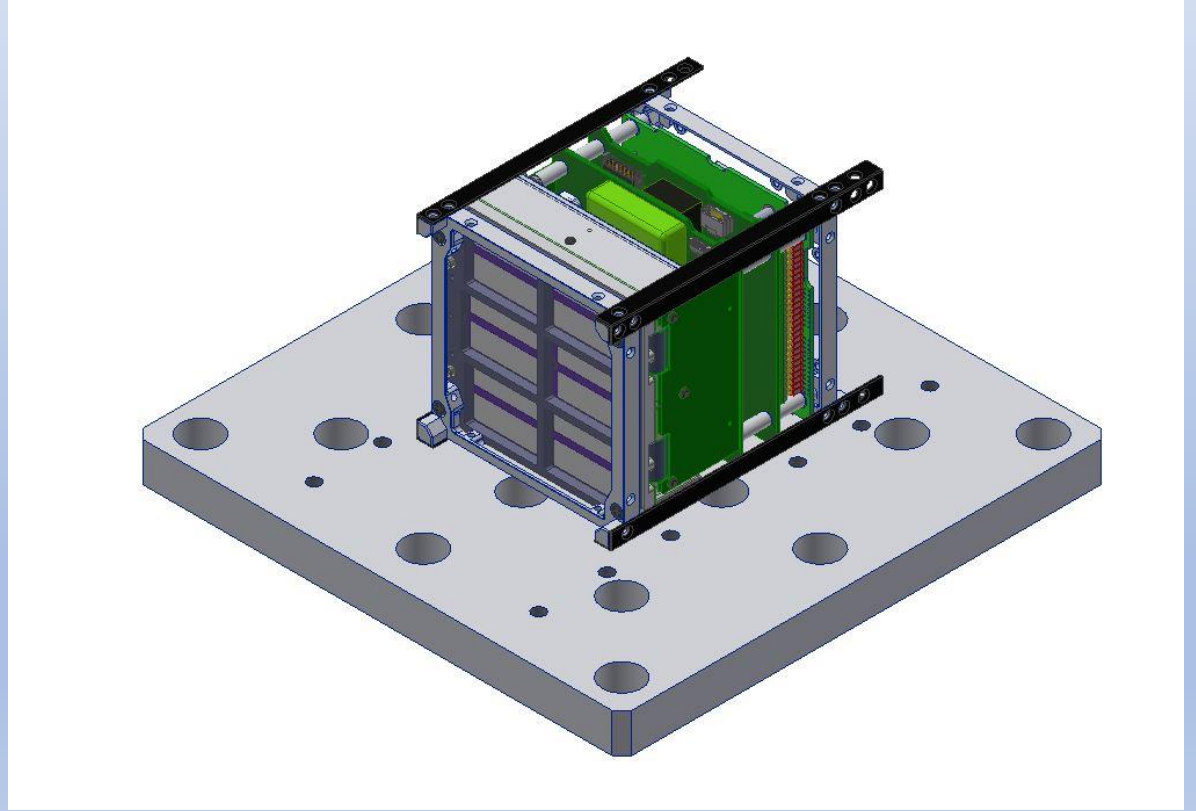
GSE AND **TEST TOOLS**



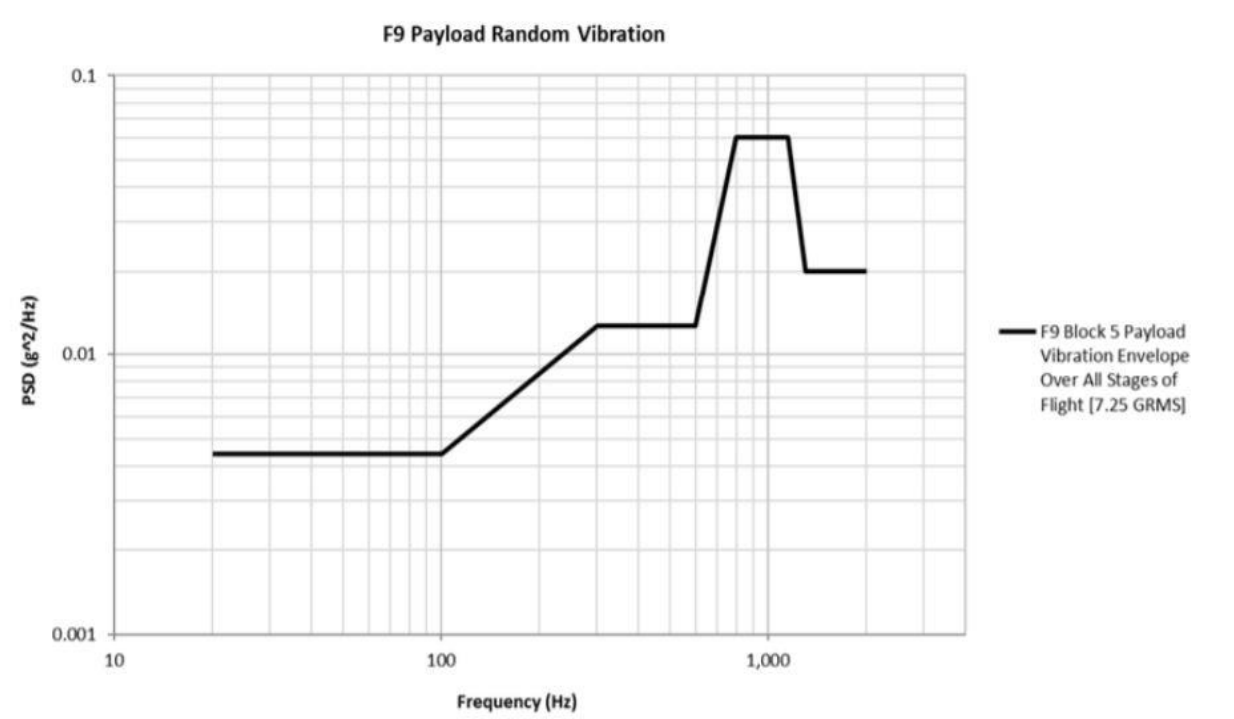
FIXTURE:

- I/F BETWEEN UNIT UNDER TEST AND SHAKER
- NOT TO AMPLIFICATE INPUT EXCITATION LEVELS

- UUT CLAMPED RIGIDELY ON THE FIXTURE (TBD)
- REPRESENTATIVE OF DISPENSER CONSTRAINTS



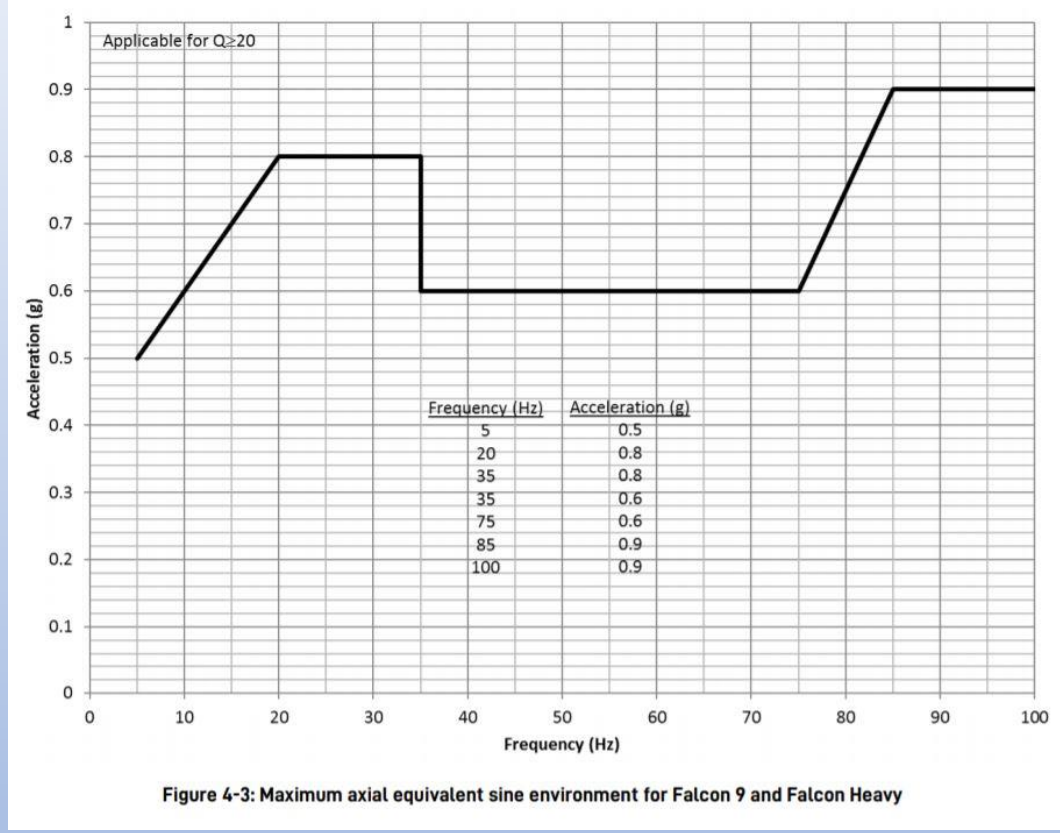
INPUT LEVEL (EXAMPLE)



RANDOM VIBRATION ENVIROMENTAL LEVELS

Frequency (Hz)	SRS (g)
100	30
1000	1,000
10000	1,000

SHOCK RENSPONSE SPECTRUM



AXIAL EQUIVALENT SINE ENVIRONMENT

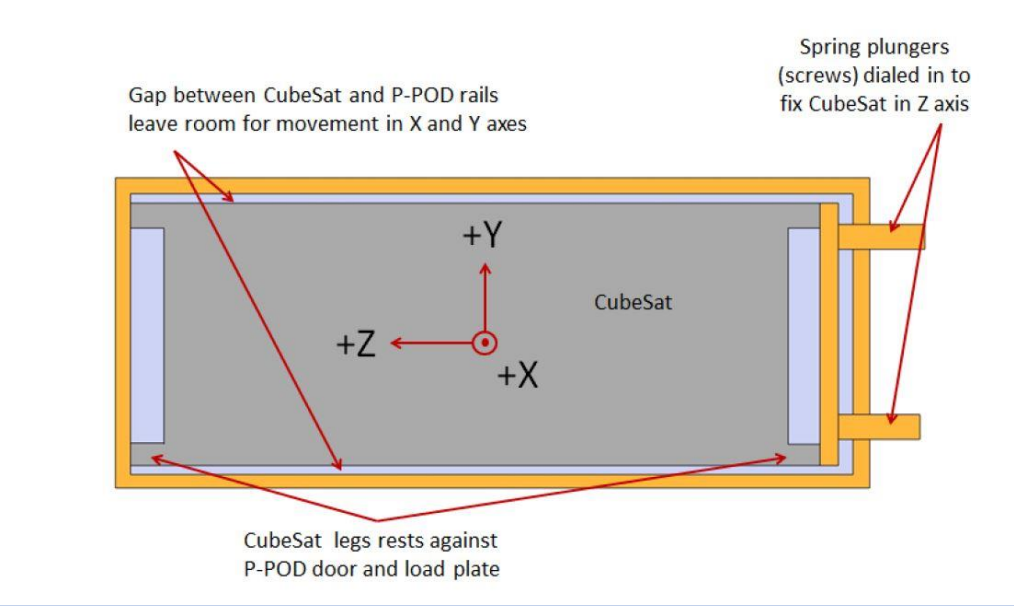
VIBRATION MODES & **RANDOM VIBRATION:** FEM ANALYSES EVALUATION

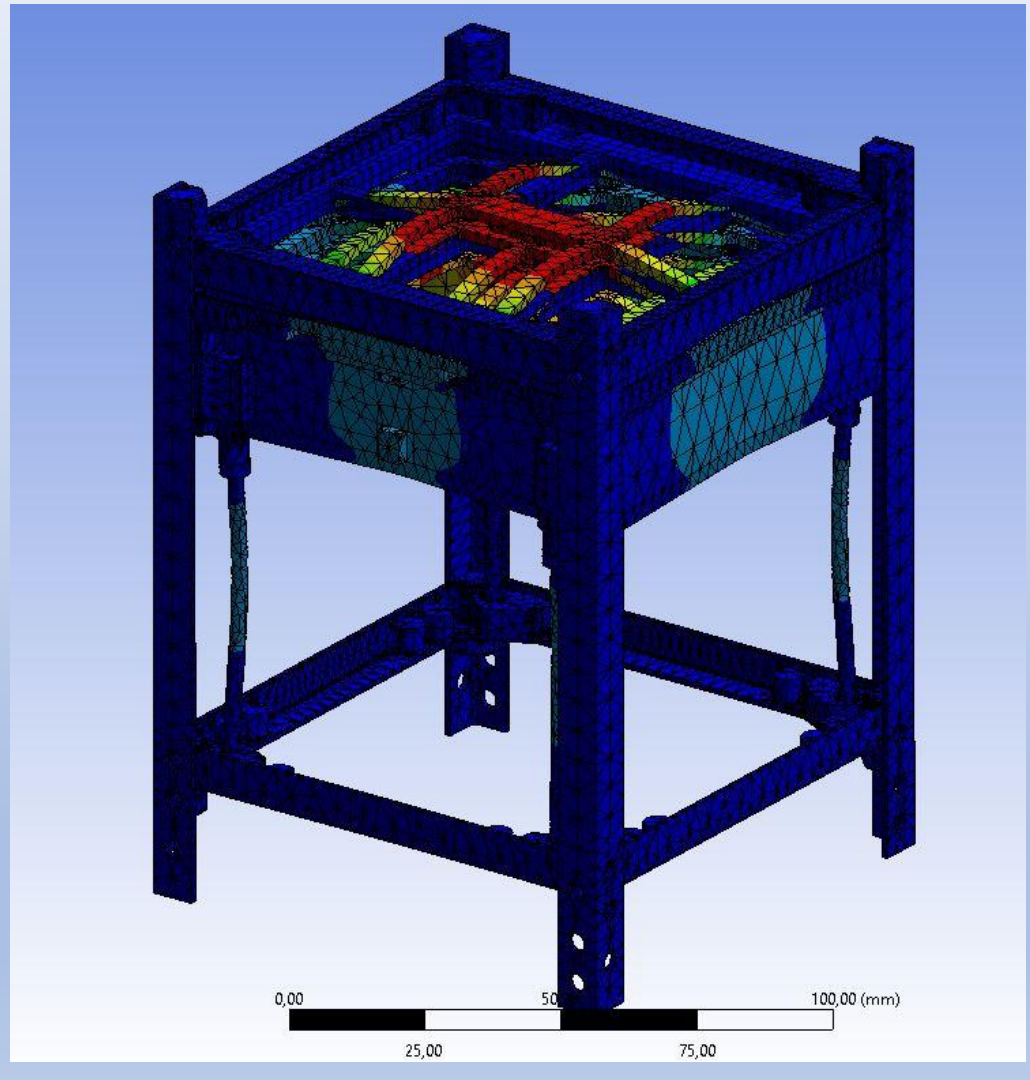
- GENERATE A **SIGNIFICATIVE - SIMPLIFIED P/L MODEL** FOR FEM ANALYSES

- **MATERIAL MECHANICAL PROPERTIES** ACCURATELY ASSIGNED

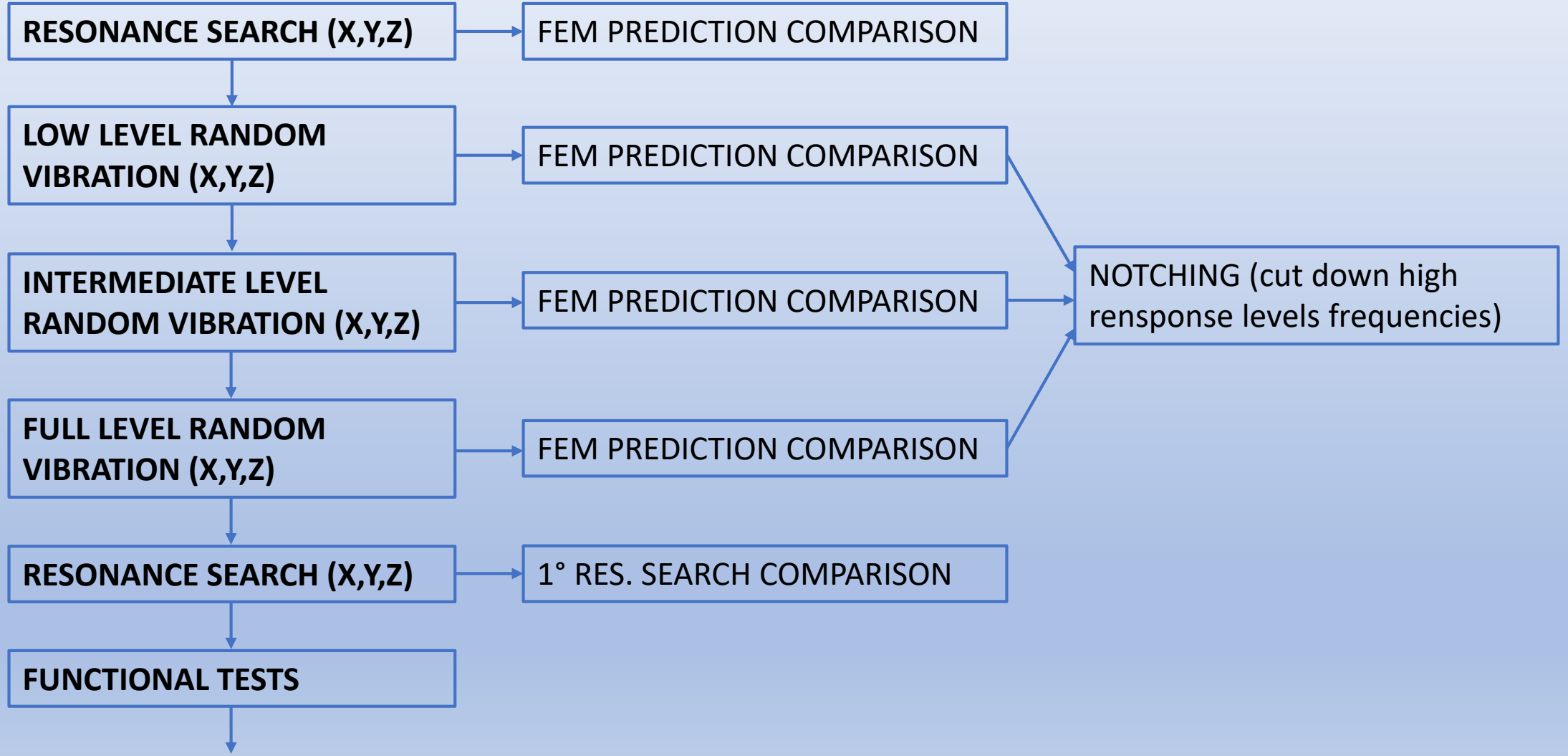
- **ACCURATE MODEL OF** BOLTED and GLUED **CONNECTIONS** (SCREWS, EPOXY, SILICONE PADS)

- MODEL OF **ACTUAL DEPLOYER C/S CONSTRAINTS**





RANDOM VIBRATION TEST STRATEGY



OPEN POINTS

ESTABLISH LAUNCH ENVIRONMENT PRELIMINARY DEFINITION

CONSIDER **DEPLOYER TRANSFER FUNCTION** TO BETTER EVALUATE C/S VIBRATION LEVELS

FINALIZE A REPRESENTATIVE **P/L FEM MODEL**

PERFORM **MODAL & RANDOM VIBRATION ANALYSES** USEFUL FOR TEST PREDICTION

DEFINE P/L VIBRATION TEST **PASS/FAIL CRITERIA**

PROVIDE **PCBs DUMMIES** FOR VIBRATION TESTS

THANKS FOR YOUR ATTENTION

ANY QUESTION?