

SPACECRAFT CHARGING

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GENERAL COMMENTS

- SPACECRAFT CHARGING INTERACTIONS COUPLE ENVIRONMENT TO SYSTEM PERFORMANCE THROUGH MATERIALS
- TECHNOLOGY IS STILL DEVELOPING
 - CONCERN FOR BOTH ENVIRONMENT-DRIVEN & OPERATING SYSTEM - DRIVEN INTERACTIONS
- MEETING ADDRESSED ENVIRONMENT BUT LACKED SPECIFIC MISSION REQUIREMENTS
 - REQUIRE SYSTEM DEFINITION TO PRIORITIZE INTERACTIONS
 - RECOMMEND SDI BRIEF SYSTEMS REQUIREMENTS
- NEED ADDITIONAL GROUP SUPPORT WORK TO SUPPLEMENT FLIGHT EXPERIMENTS

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MATERIAL PROPERTY CHANGES WITH ELECTRICAL STRESS AND TIME IN SPACE ENVIRONMENT

- WHY PROBLEM:
 - STRESS ENHANCES AGING
 - RADIATION INDUCED INTERFACE FAILURES:
 - CURRENT SPACECRAFT BEHAVIOR STARTING TO BE UNDERSTOOD BUT MATERIALS AND OPERATING CONDITIONS CHANGING
 - LIFETIME EXTENDED
- GROUND TEST/THEORY CORRELATION:
 - DIELECTRIC COMMUNITY WORKING
 - SHORT TERM TESTING WITHOUT SPACE ENVIRONMENT
- WHAT IS STILL NEEDED
 - MATERIALS TESTING TO ESTABLISH RANGE OF INTERACTION

MATERIAL PROPERTY CHANGES WITH ELECTRICAL STRESS AND TIME IN SPACE ENVIRONMENT (CONTINUED)

- WHY REQUIRE SPACE FLIGHT:
 - NEED SPACE ENVIRONMENT TO VERIFY BEHAVIOR
 - HIGH ALTITUDES OR POLAR FOR RADIATION
 - TIME IN ENVIRONMENT
- SUPPORTING WORK:
 - DIELECTRIC COMMUNITY
 - NOT DIRECTED TOWARDS SPACE APPLICATIONS

CANDIDATE EXPERIMENTS

- MATERIAL PROPERTY CHANGES WITH ELECTRICAL STRESS AND TIME IN SPACE ENVIRONMENT
- HIGH VOLTAGE SYSTEM INTERACTIONS
- THIN-FILM COATING INTERACTIONS
- DISCHARGE CHARACTERIZATION
- "TAILORED" MATERIALS
- HEAVY STRESSED POWER SYSTEM DIELECTRICS
- PULSED POWER SYSTEM INTERACTIONS
- COMPOSITE INTERNAL NOISE GENERATION
- ACTIVE CHARGE CONTROL
- "RADIATION BELT" CHARGING

RADIATION BELT CHARGING BY ENERGETIC PROTONS AND ELECTRONS

- WHY PROBLEM:
 - UPSET SEEMS TO OCCUR ON GPS
 - NO CHARGING MODEL EVALUATION
- GROUND TEST/THEORY CORRELATION
 - SHOULD BE ABLE TO TREAT BUT HASN'T BEEN YET
- WHAT IS STILL NEEDED:
 - EVALUATION OF EFFECT OF ENVIRONMENT
- WHY REQUIRE SPACE FLIGHT:
 - NEED ENVIRONMENT AND TIME IN SPACE

ACTIVE CHARGE CONTROL INTERACTIONS

- **WHY PROBLEM:**
 - THIS IS A CHARGING MITIGATION TECHNIQUE, BUT IT CAN DEGRADE COATINGS BY BOMBARDMENT TIME EFFECT
- **GROUND TEST/THEORY CORRELATION:**
 - SHORT TERM TESTING
 - MODEL EXISTS BUT NOT VALIDATED
- **WHY REQUIRE SPACE FLIGHT:**
 - LONG TERM STUDY IN SPACE WITHOUT WALLS
- **SUPPORTING WORK:**
 - AFGL CHARGE CONTROL SYSTEM (XENON)
 - IAPS (MERCURY)

PULSED POWER INTERACTION-SYSTEM DYNAMIC RESPONSE TO 1 TO 100/SEC POWER PULSE

- **WHY PROBLEM:**
 - BEHAVIOR IN PLASMA UNCERTAIN
 - AFFECTS SYSTEM PERFORMANCE
 - FLASHOVER
- **GROUND TEST/THEORY CORRELATION:**
 - THEORY BEING DEVELOPED
- **WHAT IS STILL NEEDED:**
 - THEORY AND TESTS DEMONSTRATION
- **WHY REQUIRE SPACE FLIGHT:**
 - NEED SPACE ENVIRONMENT
 - RADIATION ENVIRONMENT IMPORTANT
- **SUPPORTING WORK:**
 - SPEAR II
 - TEXAS TECH AND MAXWELL (TESTING)

NOISE GENERATED IN COMPOSITES
**(SPACE INDUCED CHARGING COUPLED WITH RADIATION
TO GENERATE NOISE IN MATERIALS)**

- WHY PROBLEM:
 - RF NOISE CAN COUPLE INTO COMMUNICATIONS AND SENSORS
- GROUND TEST/THEORY CORRELATION:
 - MEASURE RF LEVELS IN SMALL SAMPLES UNDER ELECTRICAL STRESS AND RADIATION
 - THEORY ADEQUATE BUT NUMBER OF PULSES UNKNOWN
- WHY REQUIRE SPACE FLIGHT:
 - NEED SPACE FLIGHT ENVIRONMENT
 - AURORAL OR HIGH ALTITUDE
 - CAN BE ADDED TO EXISTING S/C HAVING RF DETECTION SYSTEMS

HEAVY STRESSED POWER SYSTEM DIELECTRIC
**(SDI APPLICATIONS UNDER HIGH VOLTAGE AND LARGE
CURRENTS)**

- WHY PROBLEM:
 - STRONG ELECTRICAL STRESS AND INDUCED MAGNETIC FIELD REDUCE BREAKDOWN THRESHOLDS
- GROUND TEST/THEORY CORRELATION:
 - COMPONENTS UNDER STUDY
- WHAT IS STILL NEEDED:
 - COMBINED SYSTEM EFFECTS
 - SPACE ENVIRONMENT DEMONSTRATION
- WHY REQUIRE SPACE FLIGHT:
 - TOTAL SPACE ENVIRONMENT EFFECT
 - TIME IN SPACE

SYSTEM INTERACTIONS

- SCOPE:
 - HIGH VOLTAGE
 - = HIGH VOLTAGE SOLAR ARRAYS
 - = STRUCTURE COLLECTION IN PLASMAS
 - = SCALING LAWS FOR SIZE, VOLTAGE, POWER FREQUENCY
 - = SHEATH EFFECTS
- WHY PROBLEM:
 - SYSTEM FLOATS ELECTRICALLY IN PLASMA ENVIRONMENT
 - BREAKDOWNS IN HIGH VOLTAGE SYSTEMS
- GROUND TEST/THEORY CORRELATION:
 - SMALL SCALE SAMPLE CORRELATES WITH THEORY
- WHAT IS STILL NEEDED:
 - SIZE, VOLTAGE, POWER, FREQUENCY SCALING
- WHY REQUIRE SPACE FLIGHT:
 - NEED COMPLETE SPACE ENVIRONMENT
 - CAN'T SIMULATE ON GROUND
- SUPPORTING WORK:
 - GROUND SUPPORT WORK
 - JAPANESE SPACE EXPERIMENT

THIN FILM COATING-STABILITY OF THIN-FILM OPTICAL AND ELECTRICAL COATINGS IN SPACE ENVIRONMENT

- WHY PROBLEM:
 - COATING APPLIED FOR SPECIFIC OPTICAL OR ELECTRICAL PURPOSE SPACE--
- SPACE
 - SPACE CHARGING INTERACTION COUPLED WITH SPUTTERING OR CONTAMINATION MAY DESTROY COATING CHARACTERISTICS
- GROUND TEST/THEORY CORRELATION:
 - SHORT TERM TESTING
 - FLIGHT DATA NOT INSTRUMENTED FOR DETAILED EXAMINATION
- WHAT IS STILL NEEDED:
 - IDENTIFICATION OF COATINGS
- WHY REQUIRE SPACE FLIGHT:
 - NEED SPACE ENVIRONMENT

DISCHARGE CHARACTERIZATION

- SOURCES:
 - WHAT ARE CONDITIONS FOR DISCHARGE INITIATION
- CHARACTER:
 - FREQUENCY, AMPLITUDES, REP RATE, TRANSFER FUNCTION, AND CHANGES WITH TIME IN SPACE
- WHY PROBLEM:
 - PROTECTION OF SYSTEM CIRCUITS DEPENDS ON KNOWLEDGE OF DISCHARGES
- GROUND TEST/THEORY CORRELATION:
 - DEDUCE DISCHARGE BEHAVIOR IN SPACE
 - CHARACTERISTICS NOT REPEATABLE
- WHAT IS STILL NEEDED:
 - THEORY AND TEST CORRELATION
- WHY REQUIRE SPACE FLIGHT:
 - NEED TOTAL ENVIRONMENT AND SPACECRAFT CONFIGURATIONS

"TAILORED" MATERIALS

- SCOPE:
 - MATERIALS DEVELOPED FOR PROPERTIES TO MINIMIZE CHARGING LEVELS
 - CONDUCTIVITIES IN RANGE 10^{-8} TO 10^{-10} S/M²
- WHY PROBLEM:
 - CAN MITIGATE CHARGING CONCERNS
- GROUND TEST/THEORY CORRELATION:
 - QUASI-CONDUCTIVE MATERIALS UNDER DEVELOPMENT
- WHAT IS STILL NEEDED:
 - BETTER MATERIALS FOR THIS APPLICATION
 - DEMONSTRATE STABILITY IN SPACE ENVIRONMENT
- WHY REQUIRE SPACE FLIGHT:
 - DEMONSTRATE BEHAVIOR IN SPACE ENVIRONMENT
- SUPPORTING WORK:
 - GSFC
 - VIRGINIA TECH

SUMMARY

- IDENTIFIED INTERACTIONS THAT WOULD AFFECT SYSTEM PERFORMANCE
- BETTER DEFINITION OF SYSTEM/MISSIONS REQUIRED
- GENERAL APPROACH FOR THIS AREA:
 - SMALL SCALE GROUND TESTS
 - MODELING OF INTERACTION
 - UNDERSTANDING
 - SCALING
 - FLIGHT VERIFICATION TEST