# Launch Services Program EMC Issues

**Dawn Trout**

**VA-F3**

**Kennedy Space Center**

# Launch Services Program EMC Issues
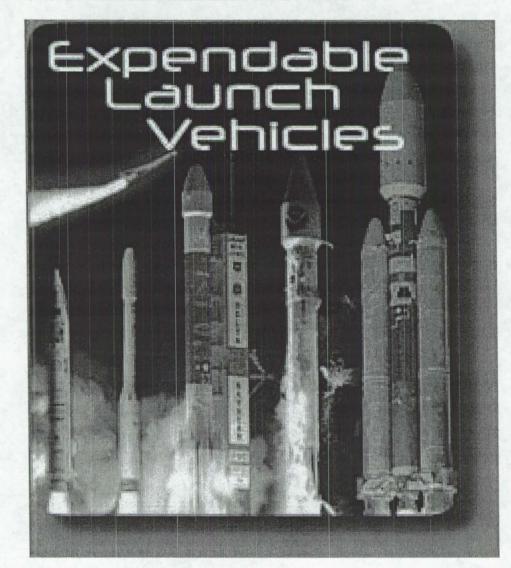
## Outline

- Vehicles of the Launch Services Program
- RF Environment
- Common EMC Launch Vehicle Payload Integration Issues
- RF Sensitive Missions
- Lightning Monitoring
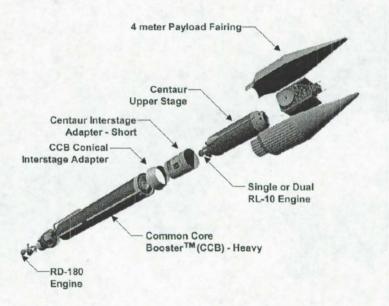
# Launch Services Program EMC Issues

## Vehicles of the Launch Services Program

- Launch Services Program
  - The Launch Services Program is the primary interface for NASA spacecraft to the commercial launch service provider .
  - Launch Services Acquisition and Management.
    - Vehicles - Delta, Atlas, Titan, Pegasus, Taurus, Athena
    - Launch Sites - Eastern - KSC, Western - VAFB, Wallops, Kodiak, Kwajalein
  - The primary focus of the LSP EMC engineer depends on the type of vehicle.
  - For ELV's with much history the emphasis is on spacecraft integration and any vehicle mission unique changes.
  - For newer ELV's, the vehicle must first be certified to be acceptable for use with NASA payloads.
  - EMC issues relate to assessing vehicle hardware changes, new vehicles, mission unique hardware, integrating the spacecraft into the Vehicle, and launchpad and flight RF environment.

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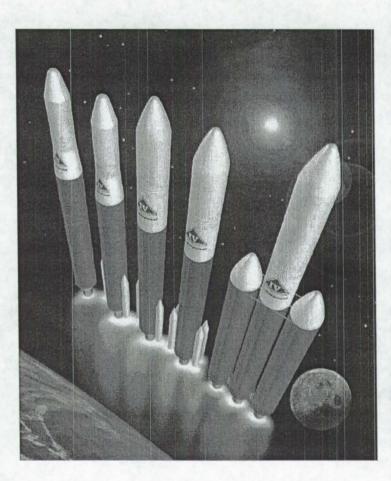# Launch Services Program EMC Vehicle Types Issues

- Atlas V (400 and 500 series) – The first flight of an Atlas V for NASA missions will be with the MRO mission. The New Horizons Pluto mission has also been manifested on an Atlas V.
  - EMC related changes from the Atlas II
    - Composite Fairing
    - Change in Antenna locations with respect to the payload
    - Change in Command Decoder Frequency
    - New Launch Pad and lightning protection system

4 meter Payload Fairing

Centaur Upper Stage

Centaur Interstage Adapter - Short

CCB Conical Interstage Adapter

Single or Dual RL-10 Engine

Common Core Booster™(CCB) - Heavy

RD-180 Engine

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## Vehicle Types

- Delta IV – GOES N will be the first NASA payload on Delta IV.
  - EMC related changes from the Delta II
    - Composite Fairing already exists on 10 ft fairing
    - Change in Antenna locations with respect to the payload
    - New Launch Pad and lightning protection system
    - Manufacturing Facility Changes



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## Vehicle Types

- Pegasus and Taurus – NASA has flown many Pegasus missions. DART is NASA's first payload to use part of the Pegasus hardware as the payload. GLORY is NASA's first primary payload on a Taurus.
  - EMC related changes from standard Pegasus mission
    - Conducted Compatibility
    - Grounding changes
    - New Transmitter
    - 1st Stage (Taurus)

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# RF Environment

- KSC – The RF environment at KSC and CCAS due to range and nearby radars is defined in the Cape Canaveral Spaceport Radio Frequency Environment, Aerospace Report No. TOR-2001. This document provides emitter information for each launch pad and processing facility. It is FOUO so its contents can not be printed in this forum.
  - The RF environment is continuously monitored at various launch pads and facilities (Shuttle Pads, O&C, EML, Hanger AO, and Pad 17) This data over time provides typical levels from range and non-range emitters. An example of pad monitoring is provided.
  - Separate RF monitoring activities are performed as needed by the spacecraft and launch vehicle suppliers. These monitoring activities are tracked by the Active Sensor Working Group.
- VAFB – The RF environment information at VAFB is more segmented.
  - An older version of the TOR exists for VAFB.
  - Periodic monitoring and reporting of peak theoretical levels is performed and reported by ITT. No frequency information is included.
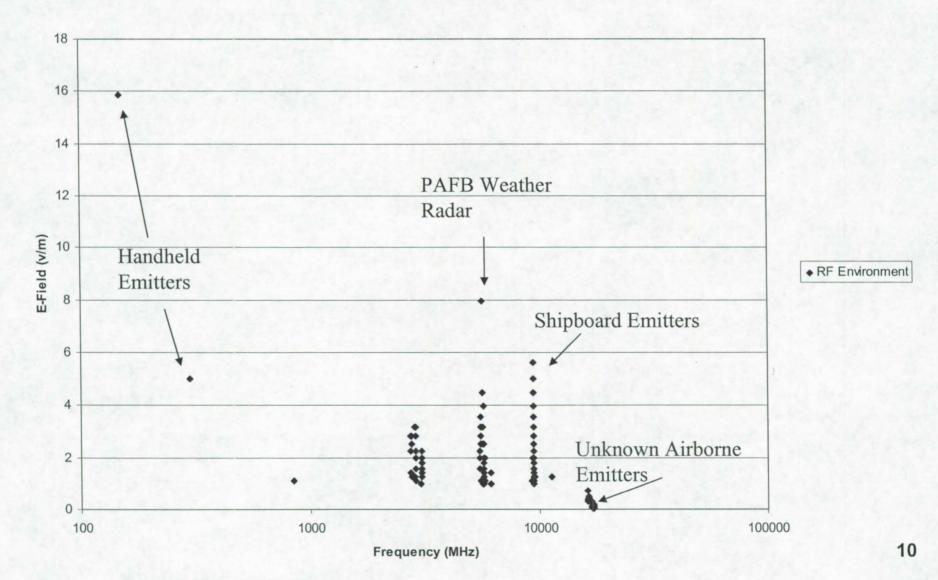  - Separate spacecraft and Vehicle RF monitoring.

# Launch Services Program EMC Issues

- Spacecraft and Vehicle – The RF environment caused by the spacecraft and vehicle emitter is also evaluated for each mission. The primary emitters are at S and C band for vehicles. The spacecraft emitters vary, but are often in the S and X bands.

- Launch – Other contributors to the RF environment during launch can be ground based tracking radars at various sites that the orbiting vehicle and spacecraft intercepts. These radars are not always on but are authorized for space tracking. Information regarding on-orbit environments can be obtained through the SEE program at MSFC on a FOUO basis.

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## Measured RF Environment (Pad 17B)



PAFB Weather Radar

Handheld Emitters

Shipboard Emitters

Unknown Airborne Emitters

♦ RF Environment
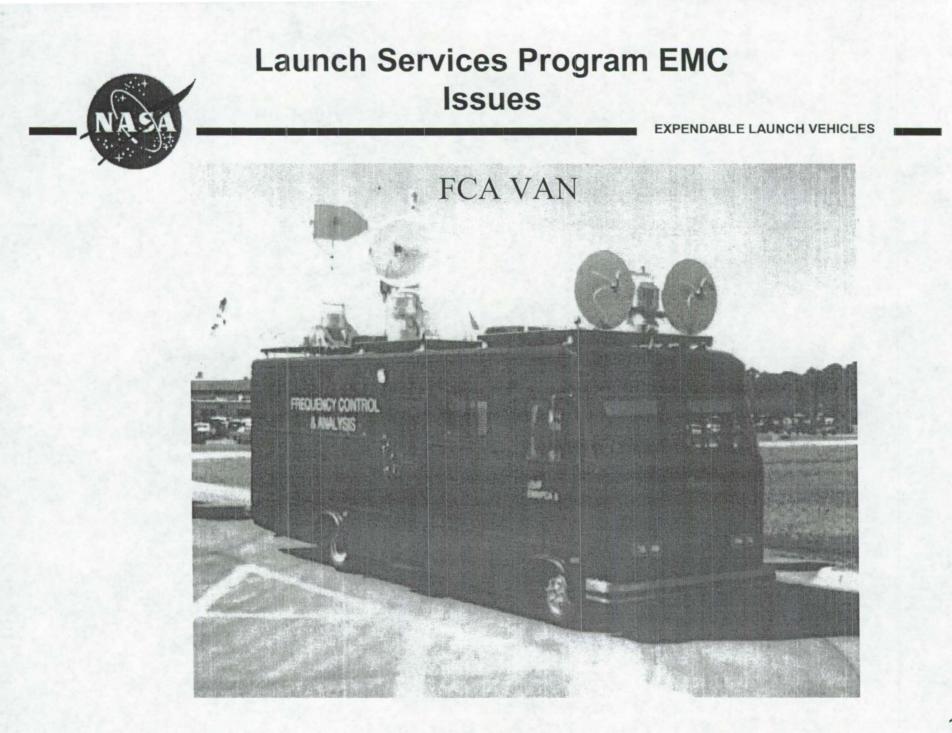
E-Field (v/m)

Frequency (MHz)

10

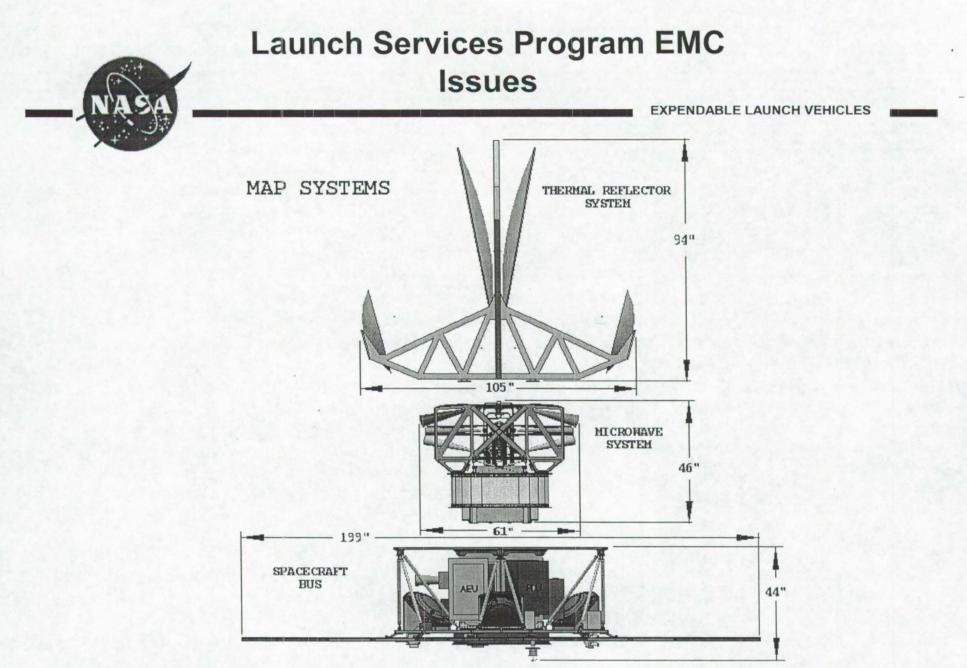## Common EMC Launch Vehicle and Payload Integration Issues

- Vehicle Certification
- Composite Bonding
- Fairing Attenuation
- Radiation in the Fairing- When a payload transmits inside a closed fairing, free space equations no longer apply and cavity effects must be considered.
  - Technique for Predicting the RF Field Strength Inside an Enclosure, NASA/TP-1998-206864 - M. Hallot, J. Redell
    - Developed prediction techniques based on conservation of energy.  Method compared to test results.
    - RF field strength shown to be a function of surface materials and surface areas.
    - GEMACS for predicting internal fairing fields
  - GOES N, NOAA N and PLUTO are current missions where transmission in the fairing will take place.

## RF Sensitive Missions – Support and Mitigation

- Determining the Launch RF Environment
    - The RF environment (based on line-of-site calculations and mitigation of range radars) is specified in Vehicle to spacecraft ICD's.
    - When spacecraft cannot meet the ICD requirements due to RF sensitivities the following approaches can be used.
        - FCA van measurement of processing facility RF environments.
        - Additional RF monitoring in sensitive frequency ranges.
        - Range coordination to control range radars and avoid Spacecraft Limits Bypass. Controlling radars below 20 V/m adds mission risk.
        - Coordination with non-range assets to control during critical periods. (Approach radars, weather radars)
        - Pad changes such as adding RF blocking materials and changing to an AC shroud with higher RF attenuation.
        - Vehicle changes such as added aperture shielding
        - Spacecraft changes such as adding antenna covers and shielding.

## FCA VAN

# Launch Services Program EMC Issues

MAP SYSTEMS

THERMAL REFLECTOR SYSTEM

94"

105"

MICROWAVE SYSTEM

46"

199"

61"

SPACECRAFT BUS

AEU

RDU

44"

Microwave Anisotropy Probe is an RF sensitive GSFC mission that measures background cosmic microwave radiation in the 16 GHz to 110 GHz region.
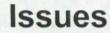
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# Lightning Detection

Most vehicles and some spacecraft have a planned check-out procedure that must be followed in the event of a lightning strike. Determining how close a lightning strike is and when the test criteria should be triggered is an issue at KSC. The following is a discussion of some of the systems available for expendable launch vehicles.

- (LDAR) Lightning Detection And Ranging System

  - 7 sensing stations detect time of arrival to detect origin.

  - Looks at a 30 mile radius with about a 500 meter accuracy.

- On-Line Lightning Monitoring System (OLMS).

  - Sophisticated system with E-Field, B dot, Current and Voltage sensors.

  - Remotely accessed data with post event processing capability.
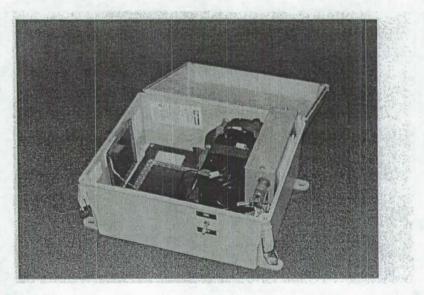
# Launch Services Program EMC Issues

## Portable Sensors

A portable lightning monitoring system was developed for use on ELVs and sensitive spacecraft by Dr. Pedro Medelius.
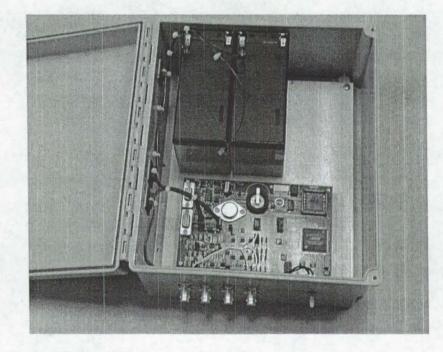
- ## Magnetic Field Sensor

  - The magnetic field sensor measures the magnetic field from a lightning strike in the vicinity of the vehicle. It is designed to respond to lightning rise times.
  - Self-contained sensor is capable of recording a waveform.
  - Three channels, including amplifiers, data converters, and First-In, First-Out (FIFO) memory are used to record and store data.
  - Sensitivity – High Gain – 0.0206 A/m/bit Magnetic Field
  - Data is downloaded periodically and after lightning events
  - Battery powered for about 1 week.



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# Launch Services Program EMC Issues
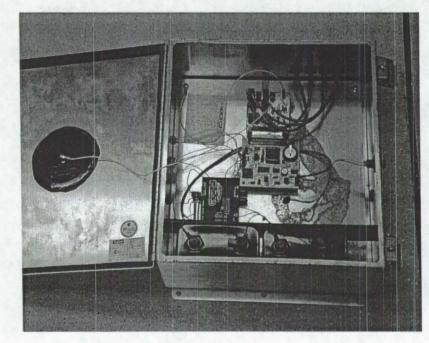
## Transient Voltage Sensor

- Voltage transients can cause immediate or latent damage to electronics. The transient voltage sensor measures transient voltages induced by lightning from line to ground.

- Records four channels simultaneously (coax connectors – can use alligator clips for connection from line to ground).

- Data is downloaded periodically and after lightning events.

- Battery powered for about 1 week.

# Launch Services Program EMC Issues

## Lightning Locator

- The SOnic Lightning LOcation (SOLLO) System uses lightning based electric field and sonic wave from thunder information to determine lightning location to within several meters .

- Existing KSC lightning locations systems are only accurate to a few hundred meters.

- Works by measuring the time between arrival of the electric field waveform and the arrival of the sonic wave.

- Contains an electric field sensor and five sonic (thunder) recorders.

- SOLLO can also be battery operated for several days and data can be down-loaded.



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## Summary

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