Multifunctional Structures Technology Demonstration on NMP DS1

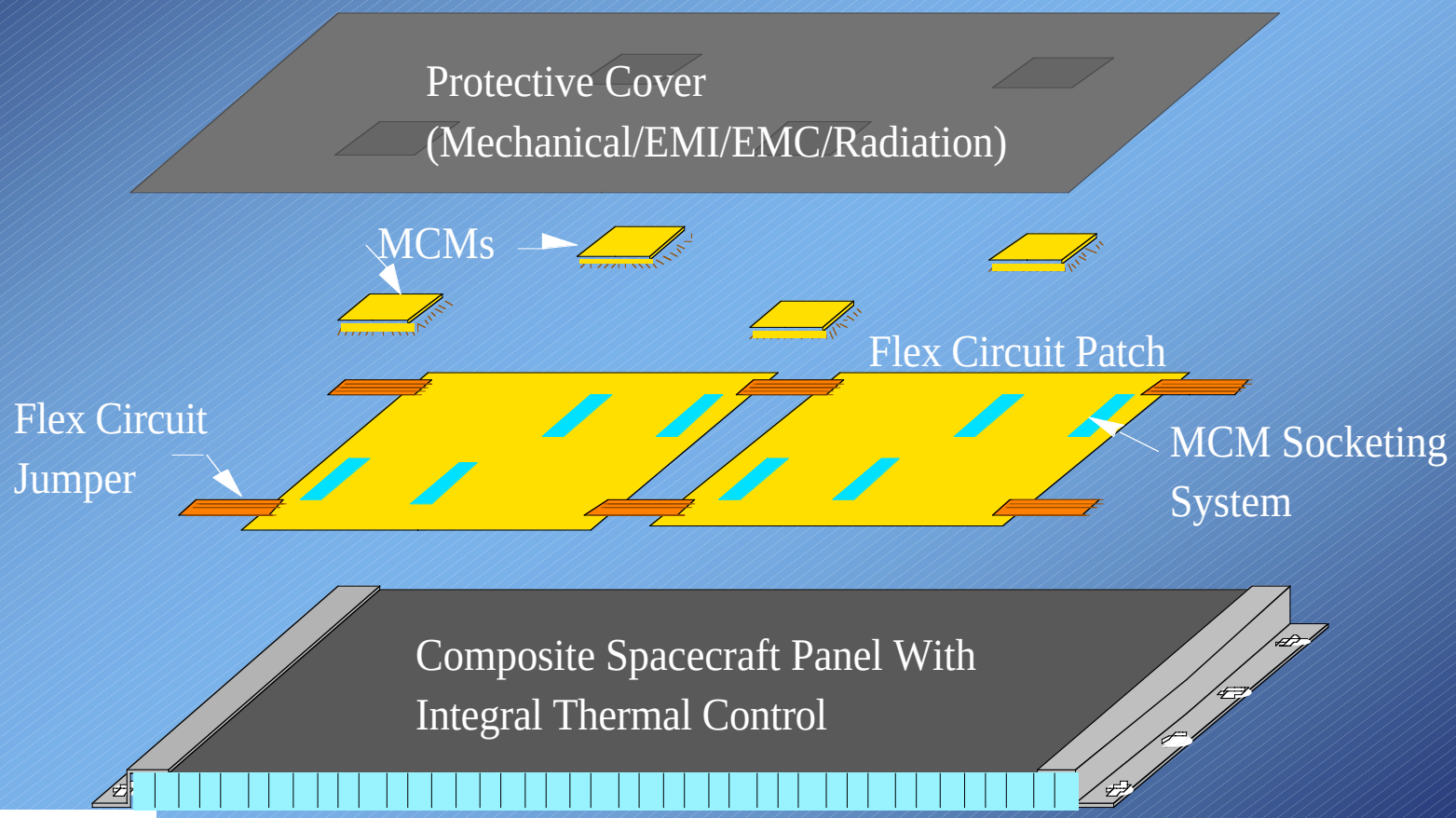
Deep Space 1 Technology Validation Symposium

David M. Barnett
Dr. Suraj P. Rawal

Multifunctional Structure Background

- Fundamental Problem: Spacecraft Cannot Efficiently Use Multichip Modules (MCMs)
  - Spacecraft built using a WWII aircraft paradigm: Discrete blackboxes mounted on structure connected with cable harnesses
  - Brilliant Pebbles Program planned on integrating an MCM stack into the Lifejacket (on-orbit carrier) and the interconnect technology did not exist ('94 timeframe)
- Research Effort Funded By AFRL/BMDO/ DARPA Led To Multifunctional Structures (MFS)
  - MFS integrates electronics, interconnects, structure and thermal control into a single packaging system

Panel Assembly



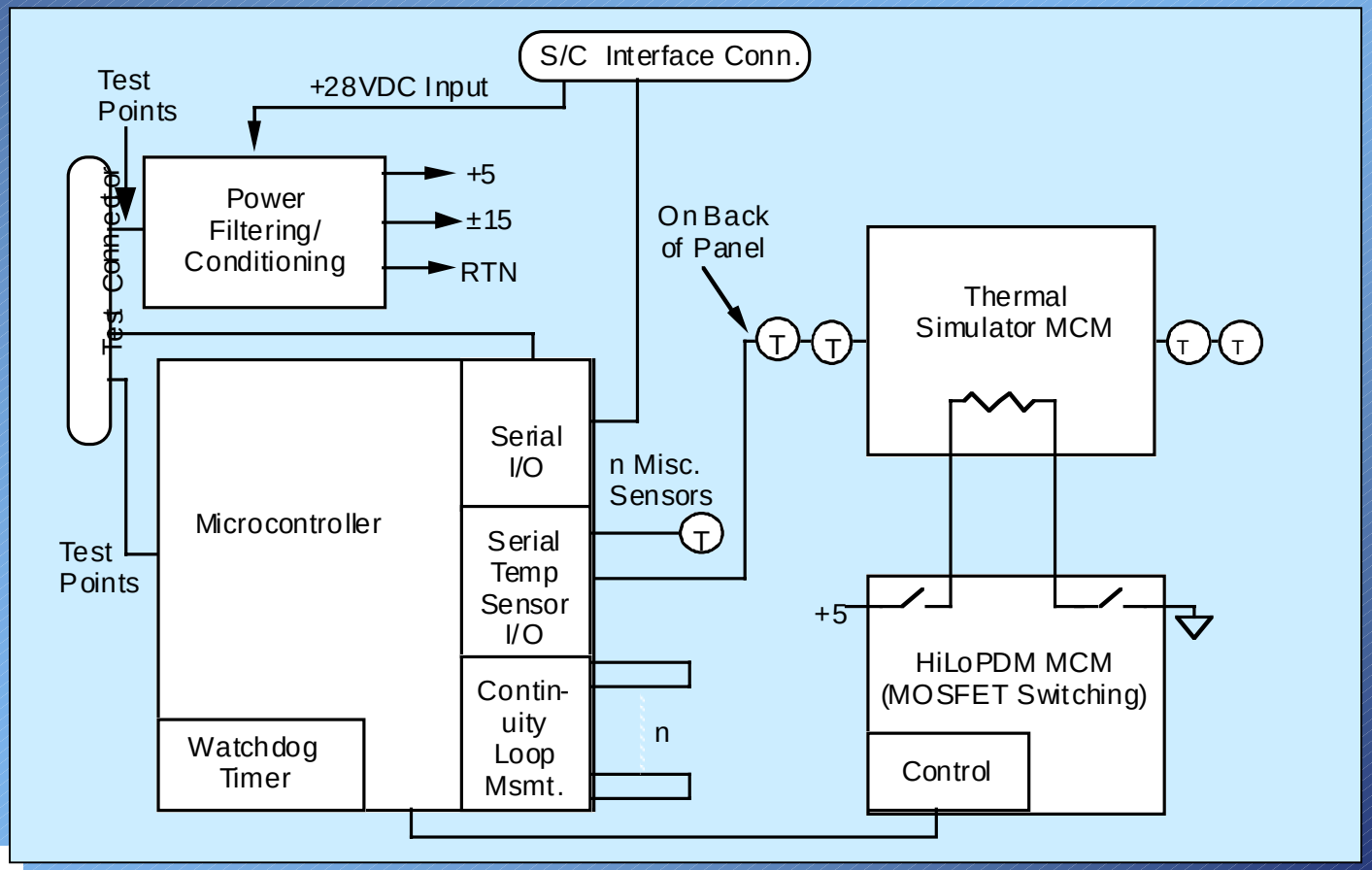
Interconnect Systems

- Flex Circuit Usage In MFS
  - Replaces both PWBs and cabling
  - Can eliminate all connectors using local bonding systems for flex-to-flex connections
  - Low mass and volume
  - Standard product
  - Conductors can be sized/added to meet voltage drop, shielding and isolation requirements
  - Supports automated assembly (future) and test

DS1 Demonstration Goals

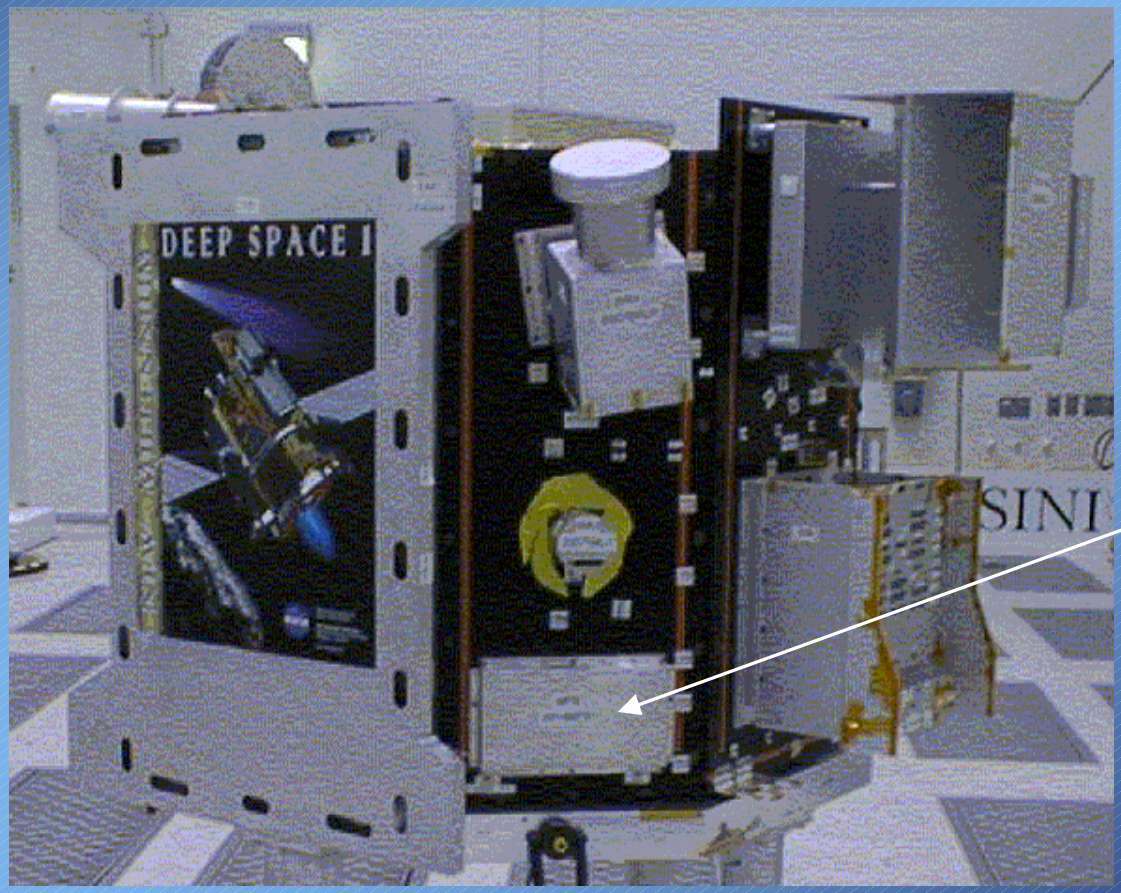
- Demonstrate And Validate MFS Technology
  - Produceability
  - Flightworthiness
  - Flex circuit patches and jumpers on structure
  - Socketed MCM
  - Distributed temperature measurements using flex tether
  - Flex circuit connections to heritage connectors (Dsubmin)
  - Hybrid cover including composite radiation shielding material

Flight Experiment Block Diagram



LOCKHEED MARTIN

Experiment Mounting Location On DS1

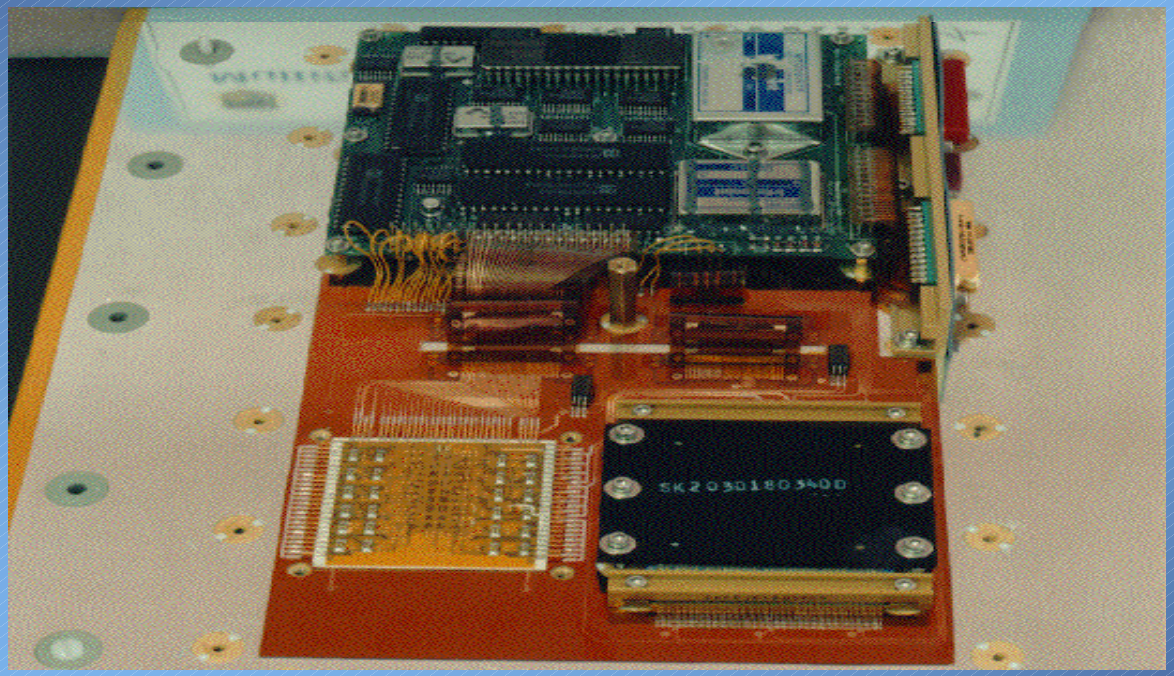


MFS Experiment

(Cover Installed)

LOCKHEED MARTIN

Flight Experiment Photo



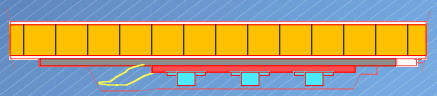
First Data Set Results

- Health And Status Data
  - Processor functions passed (EEPROM checksum, dataset checksum, rev level)
  - Power supply levels, snapshot data for conductivity and thermal
- Electrical Conductivity Measurements
  - Cal resistor levels correct - all path measurements comparable to preflight testing levels (flex circuit paths, jumpers, MCM socket)
- Thermal Gradient Measurements
  - Ambient measurements prior to dissipation pass
  - Thermal gradient observed based on distance from MCM heater

MFS Roadmap

Prior Efforts

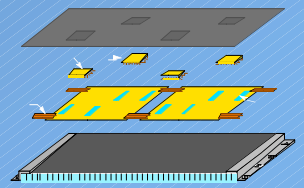
Brilliant Pebbles Tech Demo 9



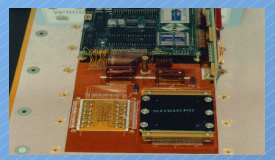
SAWAFE Panel

SIES Effort

MFS Development

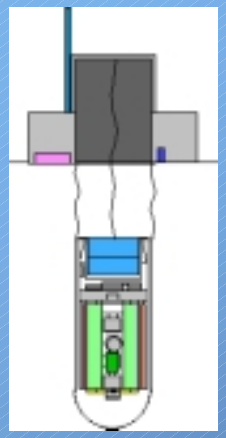


NMP DS1

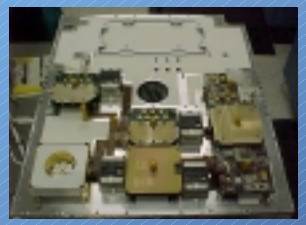


Technology Incorporation

NMP DS2

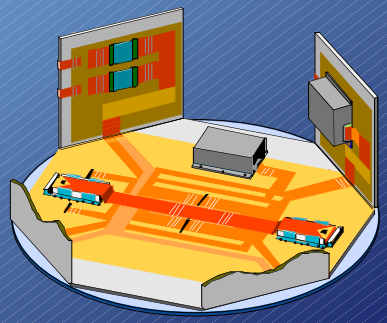


STRV



SINDRI

ATDS



Conclusions

- Multifunctional Structures Methods Are Valid For Flight Designs
  - Design, integration, test, rework, flight and operation have all been completed successfully
- MFS Technology Is A Very Strong Candidate For Reducing Mass And Volume In Spacecraft Design
  - Analyses of MFS use on existing designs have shown savings from 50% - 80% in both areas
- MFS Technology Supports The Goal Of Maximizing The Ratio Of The Volume Of Electronic Elements To Total Volume