The days of "traditional" space missions (large satellites and risk avoidance on electronics) has been replaced by "small space", risk management, and a rapidly growing commercial presence.

This topical day discusses two sides of the burgeoning changes:

- Selective emerging electronic technologies that provide potential enabling characteristics for the new regime of space, and,
- Alternative concepts for systems risk management and evaluation.

Non-Volatile Memories for Space: The Threat of Ionizing Radiation
Marta Bagatin, University of Padova

An overview of radiation effects in non-volatile memories will be provided, with emphasis on Flash and Phase Change memories. Total ionizing dose and single event effects in NAND and NOR Flash technologies will be presented, discussing possible issues in both the memory cells and the control circuitry, and the underlying mechanisms. Technology scaling trends in Flash memories will be analyzed over the last decade, going from floating gate planar cells to recent 3D architecture. The synergies between SEE and TID, as well as the impact of radiation on long term performances, such as retention and endurance, will also be covered. Recent observations of upsets in PCM cells due to very highly ionizing particles impinging at an angle will be discussed. Finally, a brief overview of the state of other emerging technologies, such as ReRAM and ST-MRAM, will be provided.

Wide-Bandgap Semiconductors in Space: Appreciating the Benefits but Understanding the Risks
Jean-Marie Lauenstein, NASA/GSFC

Dr. Jean-Marie Lauenstein, NASA Goddard Space Flight Center, will present the radiation challenges of adopting wide-bandgap semiconductors for space applications. Wide-bandgap devices are attractive for space applications due to improved performance such as faster switching speeds, lower power losses, and their ability to operate at higher temperature as compared with their silicon counterparts. Their tolerance to total ionizing dose levels (> 100 krad(Si)) further enhances the desirability of these technologies. This short course will focus on silicon carbide and gallium nitride power rectifying, switching, and RF devices as these technologies are now readily available commercially. The radiation hardness assurance issues presented by the heavy-ion radiation environment will be discussed. Effects include both catastrophic failure and cumulative degradation, challenging the practice of risk avoidance through derating and possibly requiring new test method standards unless or until truly radiation-hardened devices become available. The course will conclude with a brief survey of additional wide-bandgap technologies such as diamond and gallium oxide.
FROM COTS TO SPACE GRADE ELECTRONICS: WHICH IS THE BEST FOR YOUR MISSION?
Robert Baumann, TI

After a brief overview of chronic radiation exposure effects (total ionizing dose and neutron/proton dose) and single-event effects (SEEs) that plague microelectronics in space, we consider unintentional radiation performance enhancements that have occurred as a natural consequence of technology scaling. "Natural" technology hardening is one of the reasons consumer-off-the-shelf (COTS) parts can, in some cases, be used in commercial space applications. We then provide a couple of real-world examples of commercial manufacturing variations and demonstrate how these impact microelectronic radiation sensitivity. We conclude with a discussion of the value of lot control, screening, and custom packaging methods and how their use improves product reliability while ensuring that radiation performance meets mission needs.