

LOCKHEED MARTIN



# *Aerospace Perspective on Nanotechnology for Energy*

MISSION CONTROL CENTER

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CTO, Lockheed Martin



# Why is the Aerospace Industry Interested in Nano-energy?

- *Promises a fundamental improvement in the way we power things (vehicles, sensors, processors)*
- *More capability in a smaller volume, with lower weight and potentially lower cost but also with greater reliability and more capability*
- *New energy sources coupled with stronger, lighter materials*
- *Higher performance and quality (through assembling atomically precise materials and devices)*

# Energy Applications of Nanotech



- *Nano-powder rocket propellants yield higher burn rates/higher energy propellants - means more mass on orbit and/or longer range missiles*
- *Nano-coatings for higher temperature combustion and operations at higher velocities*
- *High efficiency solar panels using nanoscale films and nano solar cells produce more power on orbit and support improved space systems such as miniaturized satellites*
- *Nano-electronics/optics enable new light sources for sensors and smaller autonomous vehicles*

# Challenges for Energy and Environmental Applications

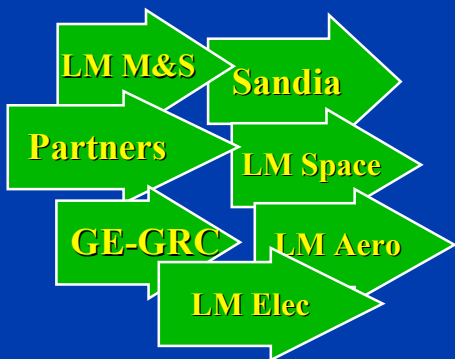


- ***Cost***
- ***Production / Manufacturing***
- ***Reliability / Failure Modes***
- ***Packaging***
- ***Reproducibility***
- ***Testing***
- ***Safety***
- ***Radiation Effects***
- ***Modeling***

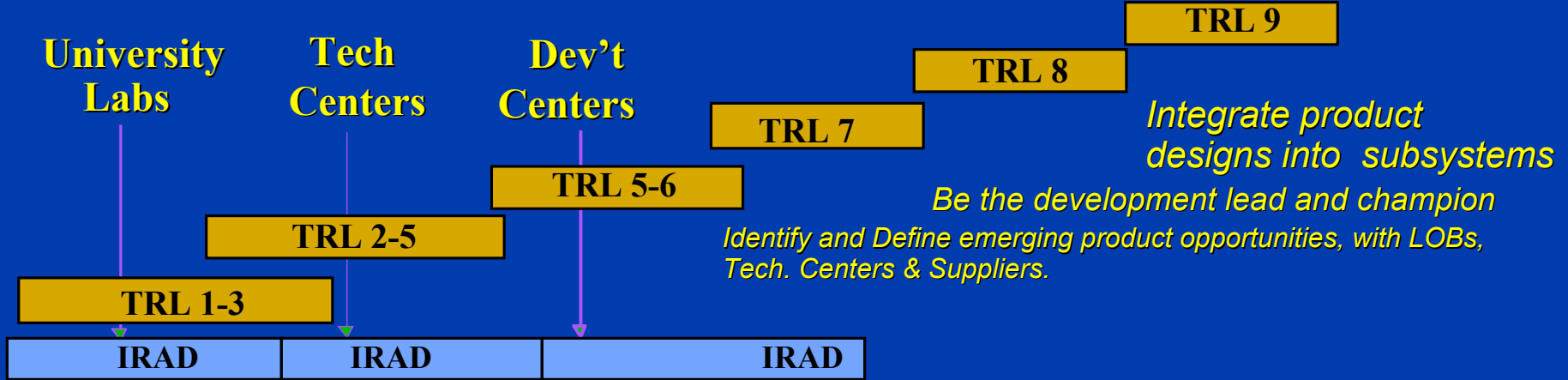
# Need to Increase Readiness of Nanotechnology (TRL Levels)



RESEARCH → PROTOTYPE → PRODUCE → DEPLOY → SUSTAIN



Programs/Systems



**Levels, Players and Objectives Are All Important in Bringing Materials and Systems to Operational Status**

# Need For Partnerships



- ***Essential to success: With payoffs being potentially long term, industry needs close alliances with universities and government labs, along with small start up companies, to obtain sufficient funding and ensure that proper attention is given to productization, with acceptable environmental impact and reliability***

