Session 2b

Staines I

High-Megawatt Converter Technology Workshop

High-Voltage, High-Megawatt Power Requirements at GA

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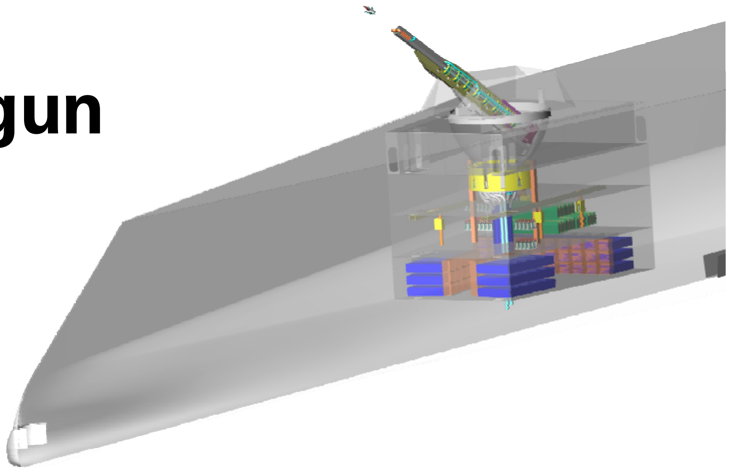
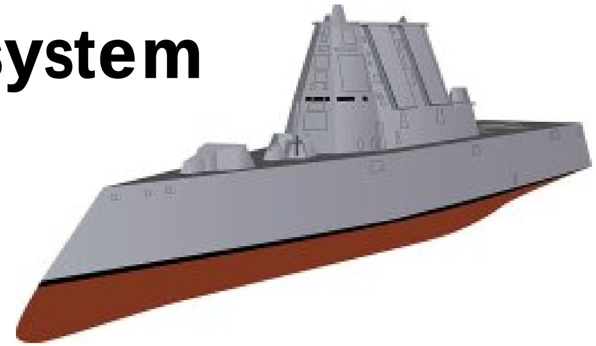
Selected GA Power Conversion Projects

- Electromagnetic Aircraft Launch System (EMALS)

- Rail gun

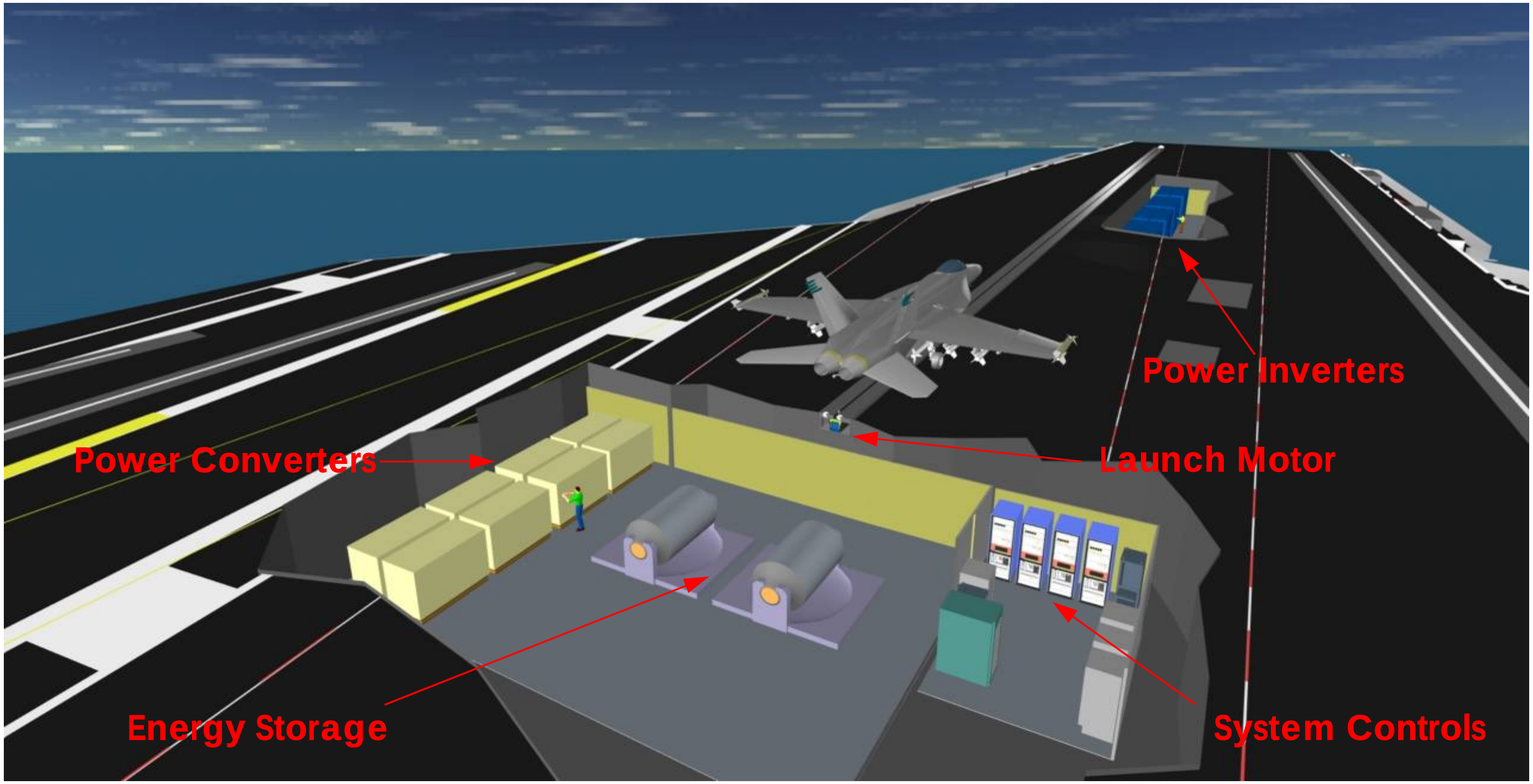


- Electric ship integrated power system



EMALS Concept

- IGBT-based inverters
- 150 MW over 2-3 seconds



EMALS Inverter Issues

- **Power density**
- **Switch power and voltage capability**
- **Pulsed operation/thermal management**
  - Present devices designed for continuous operation
  - Internal connections and thermal designs should permit full utilization of the material in the device under pulsed operation
- **Cost**
  - Advantages of lower weight and volume of an advanced switch needs to be accompanied by a reduced cost per kW

Future EMALS Switch Characteristics

PARAMETER	Where We Are	Where We Want to Be
Voltage	3300 V	5000 – 6000 V
Current	1500 A	2000 – 3000 A
Repetitive Peak Current	2400 A	4800 A
Forward Voltage Drop	2.5 V	2.0 V
Turn On Time	0.2 μs	0.02 μs
Turn Off Time	0.8 μs	0.08 μs
Switching Frequency	15-20 kHz	20 kHz
Thermal Resistance (junc-case)	0.0085 K/W	0.0042 K/W
Thermal Resistance (case-sink)	0.004 K/W	0.002 K/W

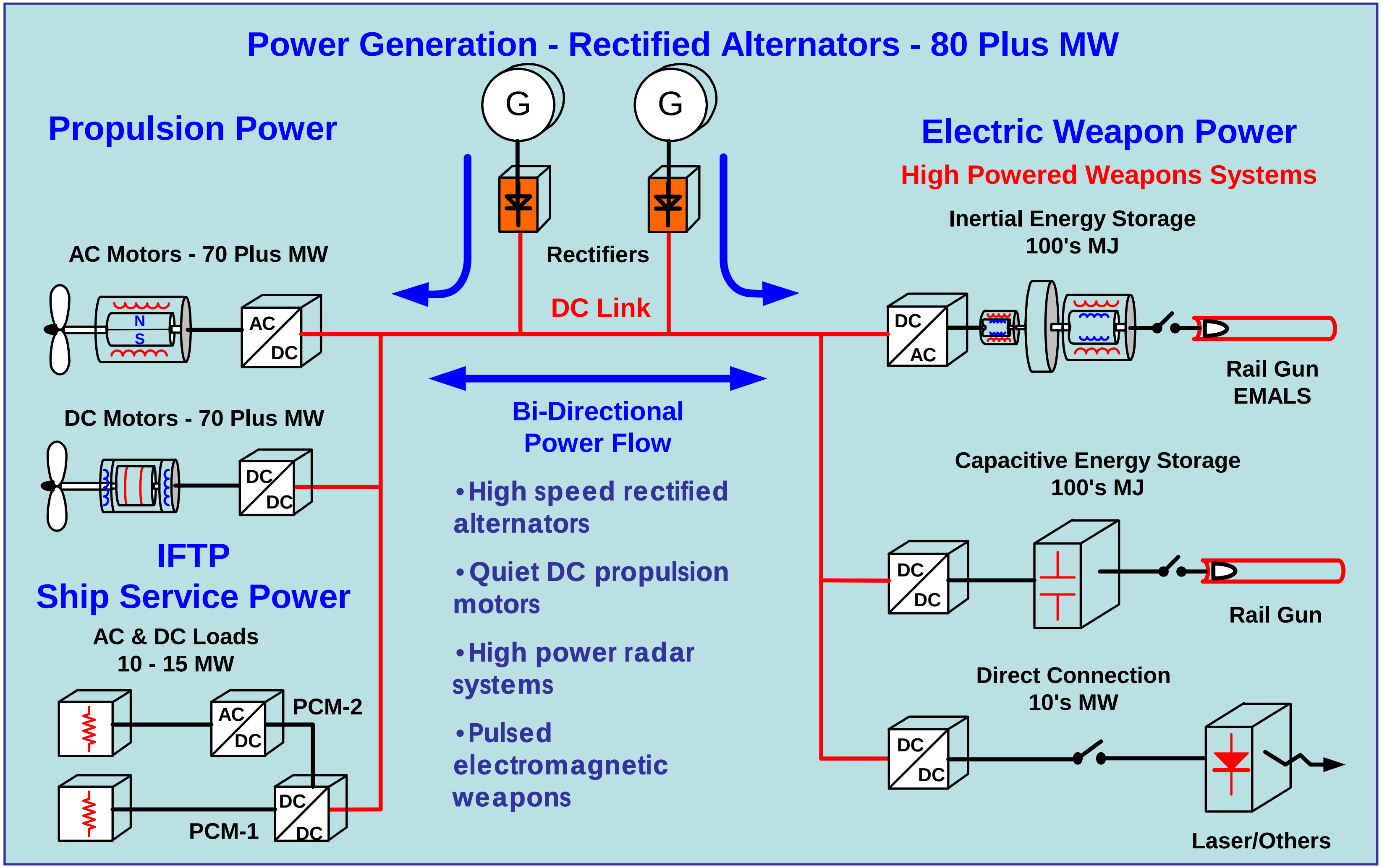
Integrated Power System (IPS) Electric Propulsion and Ship Service Power

- The first surface combatant using IPS is DDG 1000 with two propulsion motors rated at 37 MW and ship service loads > 12 MW

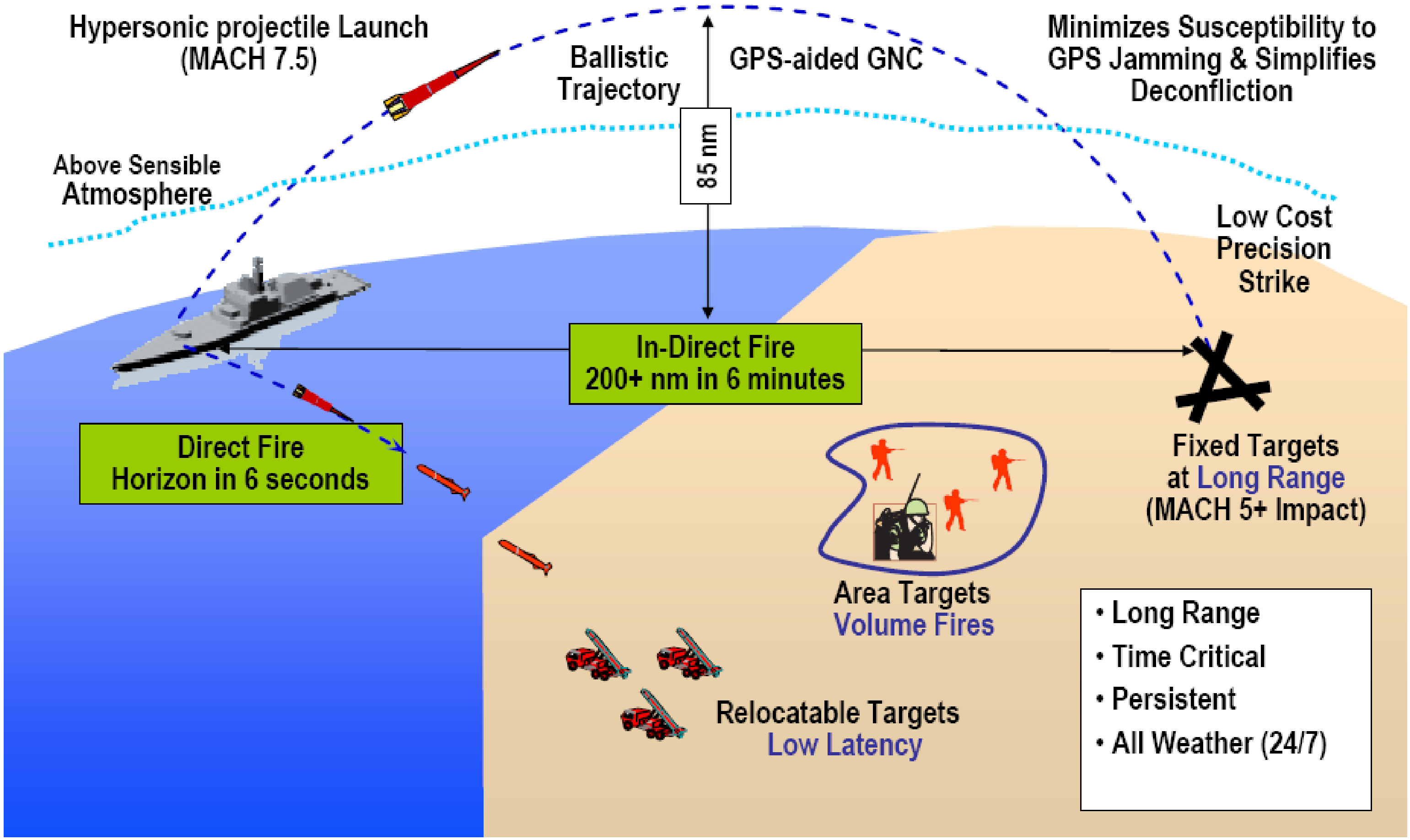
DDG 1000

- This is a major first step for IPS, but what are the next steps to meet the future IPS needs?
- Spiral insertion of new mission systems such as pulse energy weapons will increase the electric load demands even further

Flexible Power Generation, Distribution and Management

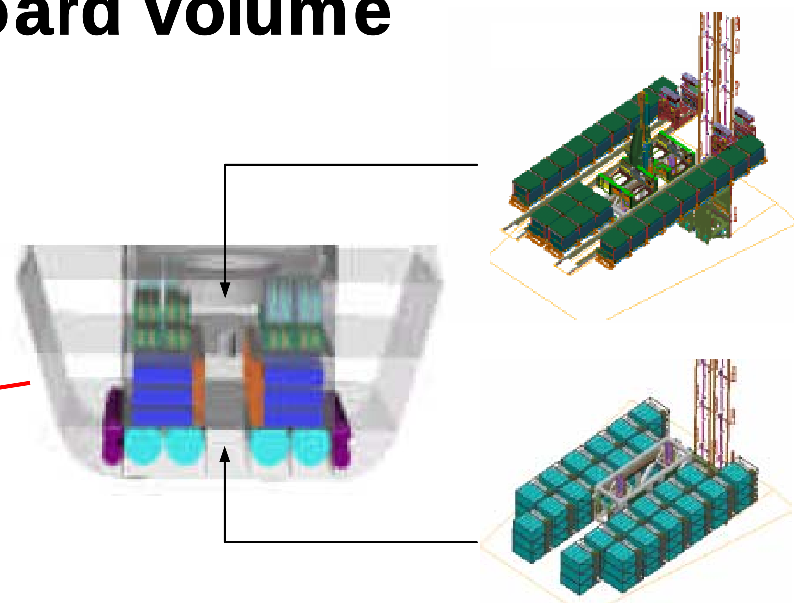


Rail Gun Mission



Rail Gun Power Requirements

- Current source to charge 200 MJ caps to 11 kV
- Max 10 shots per minute → 35 MJ/s average
- Prime power from two 35 MW MT-30 turbines
- Require high power density (> 2 MW/m^3) to fit in available shipboard volume



Charging of msec-Pulse EM Weapon Systems

- **Repetitive operation requires MW-class charger**
- **Largest part of rail gun system is cap bank**
- **2 J/cc available for charging times < 20 sec**
- **Fast charging minimizes capacitor volume, *even for single-shot operation***
- **Energy density of established capacitor films is saturated – look for reductions in rest of system**
- **Charging supply is next largest sub-system**
- **High power density MW-class chargers fundamental to practical pulsed EM weapons**