Flywheel Energy Storage System

Why Flywheels?

- A flywheel is an electro-mechanical energy storage device, which has a planned life 3 times greater than the International Space Station (ISS) Nickel Hydrogen battery.
- FESS is designed to provide more functionality and capacity than the ISS Nickel Hydrogen battery.

	FESS	Battery/Electronics
Power	4.1 kW	4.1 kW
Peak Power	5.5 kW	5.5 kW
Energy Storage	5.5 kWhr	4.6 kWhr
Contingency Power	2 orbits	1 orbit
Life Expectancy	15 years	5-6 years

In addition, the FESS provides important benefits:

- **Significant life cycle cost savings**
  - Reduced logistics (up-mass & down-mass)
  - Reduced maintenance (EVA- IVA Hr/Yr)
- **Operations advantages**
  - Higher round trip efficiency
  - Known state-of-charge
  - Offer more flexibility in charge/discharge profiles
  - Doubled contingency power (energy)

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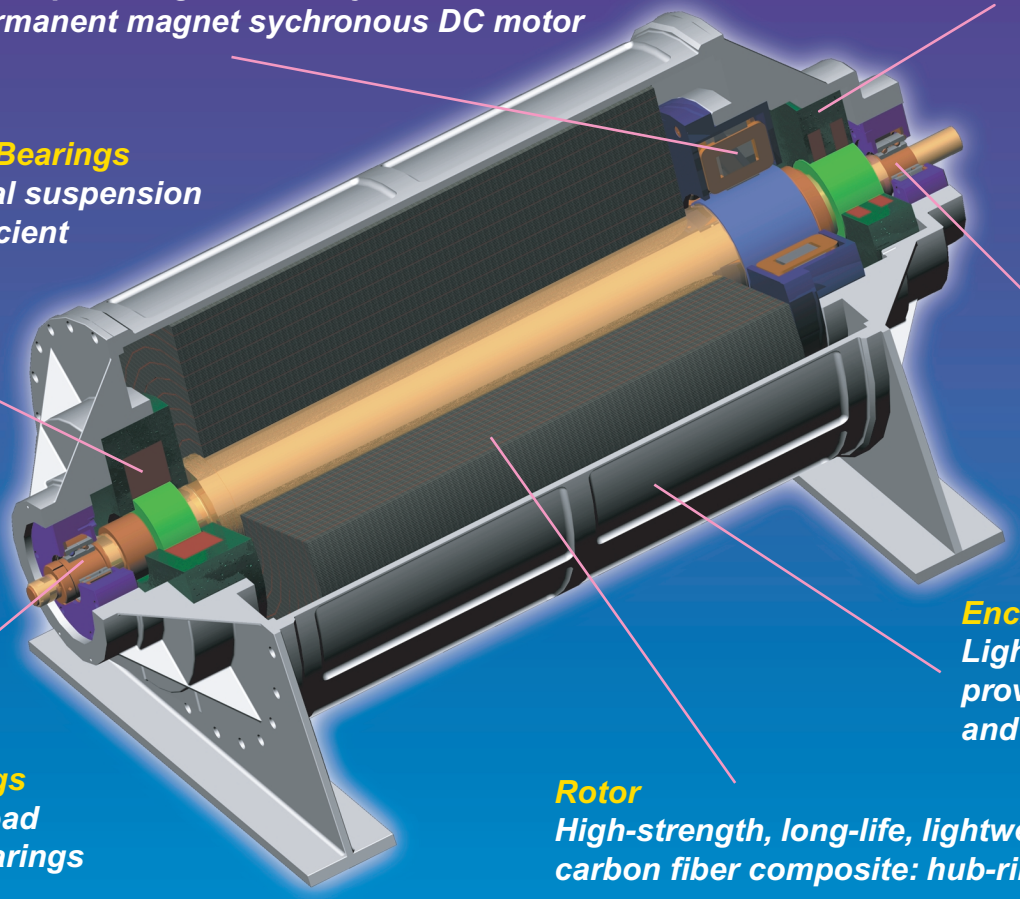
Flywheel Energy Storage System

Aerospace Flywheel Components

A flywheel is a device that stores energy in the form of
kinetic (rotating) mass and delivers electrical energy on demand.



Motor/Generator
High-speed, high-efficiency permanent magnet sychronous DC motor

Radial Magnetic Bearings
High-magnetic flux, efficient homopolar magnetics

Combination Magnetic Bearings
Provides radial and axial suspension
High-magnetic flux, efficient homopolar magnetics

Touchdown Bearings
High-speed, high-load mechanical ball bearings

Enclosure
Lightweight aluminum housing provides spacecraft mechanical and thermal interface

Touchdown Bearings
High-speed, high-load mechanical ball bearings

Rotor
High-strength, long-life, lightweight carbon fiber composite: hub-rim assembly

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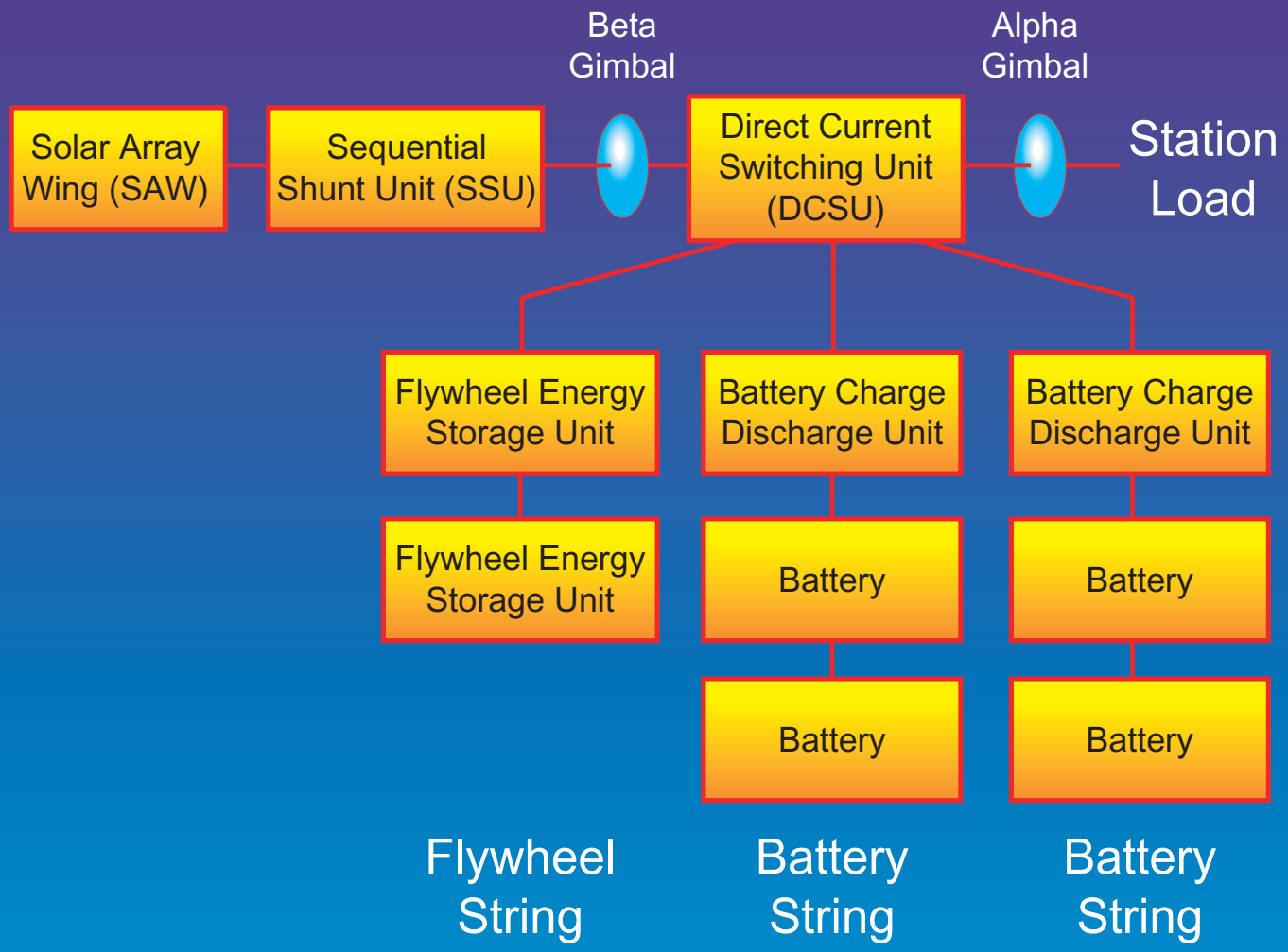
Flywheel Energy Storage System

ISS Electrical Power System with one FESS Installed



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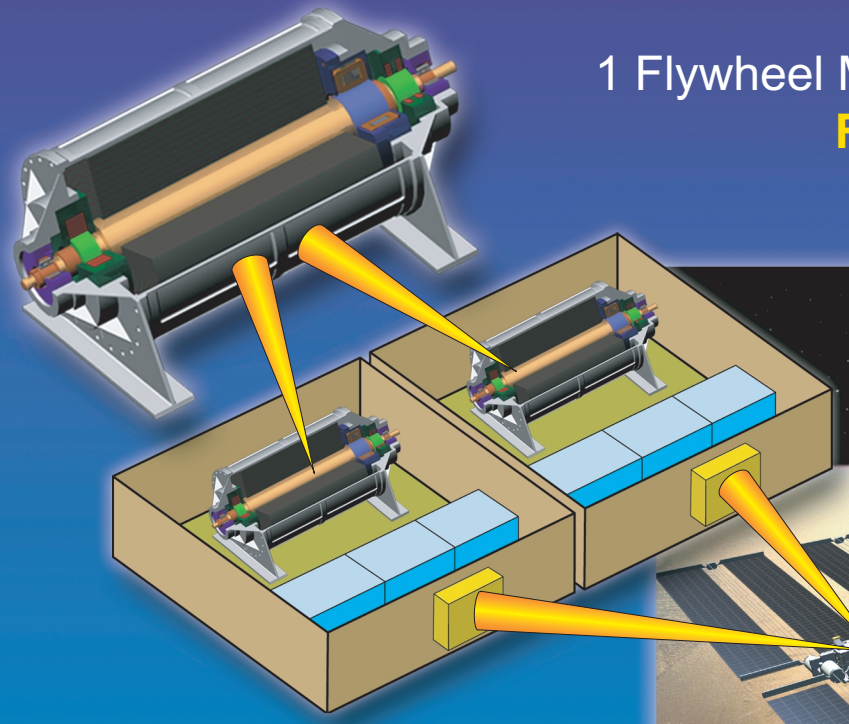
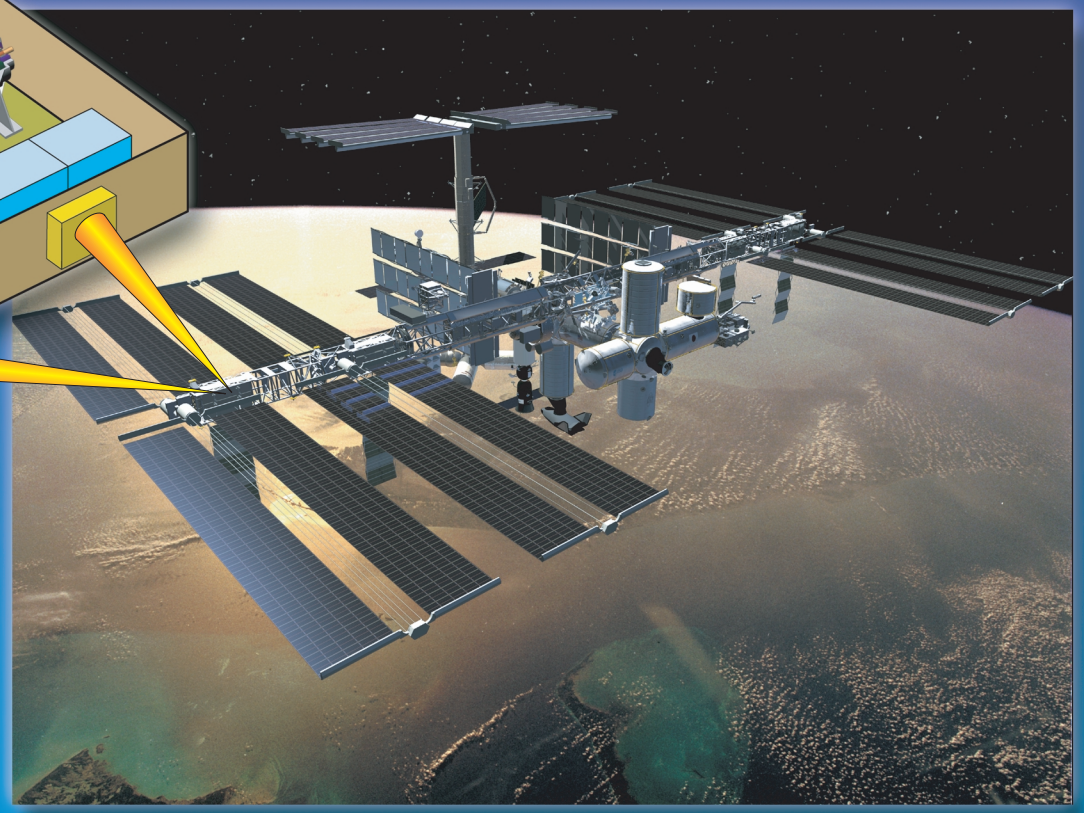
Flywheel Energy Storage System

FESS Architecture



1 Flywheel Module + 1 Set of Electonics =
Flywheel Energy Storage Unit (**FESU**)



2 Flywheel Energy Storage Units (FESU's)=
Flywheel Energy Storage System (**FESS**)

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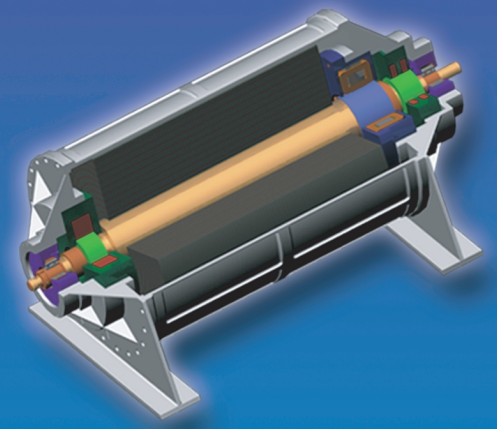
Flywheel Energy Storage System

Long Life and Reduced Costs

FESS Replaces 3 Battery Systems Over the Life of Space Station Resulting in Direct Replacement Cost Savings of $260M with additional Savings in Launch and EVA Costs



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