Solar Powered AUV

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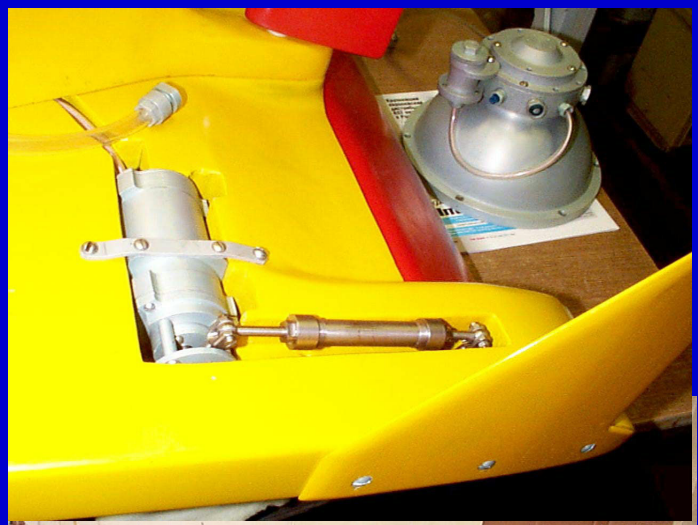
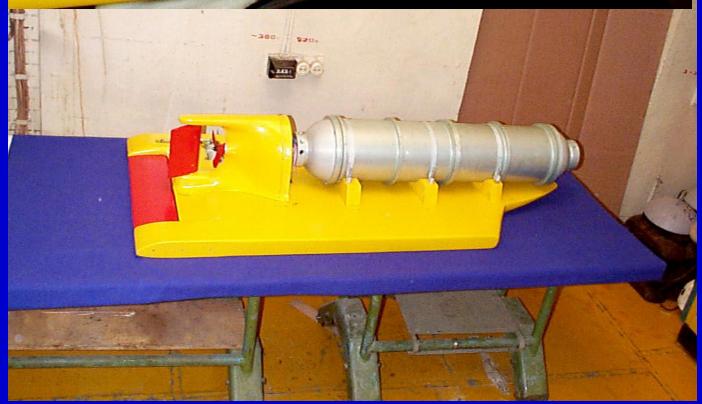
SAUV Prototype Testbed System





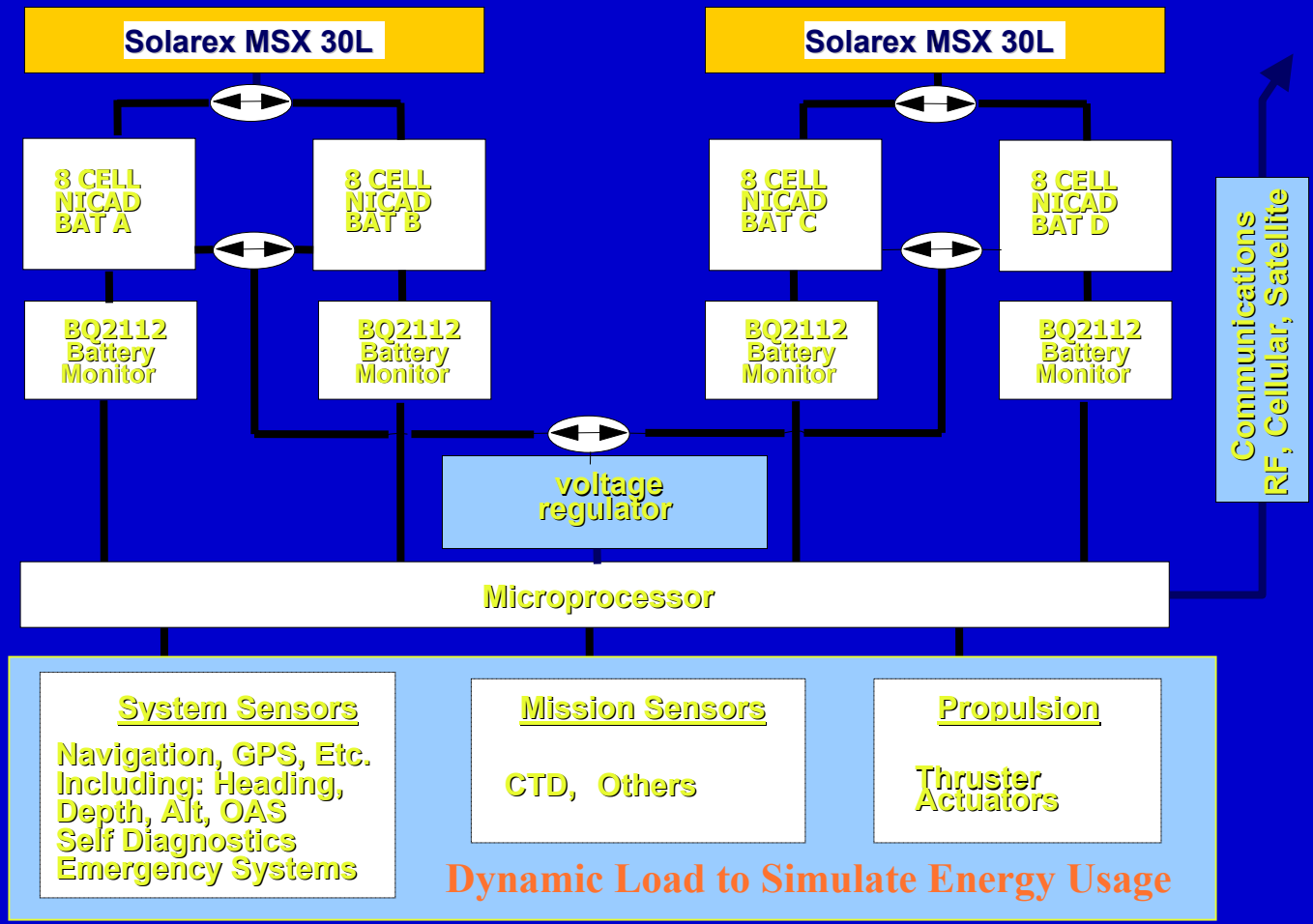
DEPTH	1000 m
DAILY TRANSIT	30 - 50 km
LENGTH	1.7 m
WIDTH	0.7 m
PRESSURE CASE	0.24 m (dia)
PV ARRAY SIZE	0.5 m^2

Solar Powered AUV (SAUV)

Program Objectives

- Parameters effecting solar energy system; collection, storage, and utilization.
- Effects of bio-fouling on solar panel coatings.
- Effect of sea wave on energy collection efficiencies.
- Investigate energy management strategies
- Integration issues for telemetry, GPS
- Design and develop tools and models
- Design and fabricate an engineering prototype solar AUV for evaluation testing.

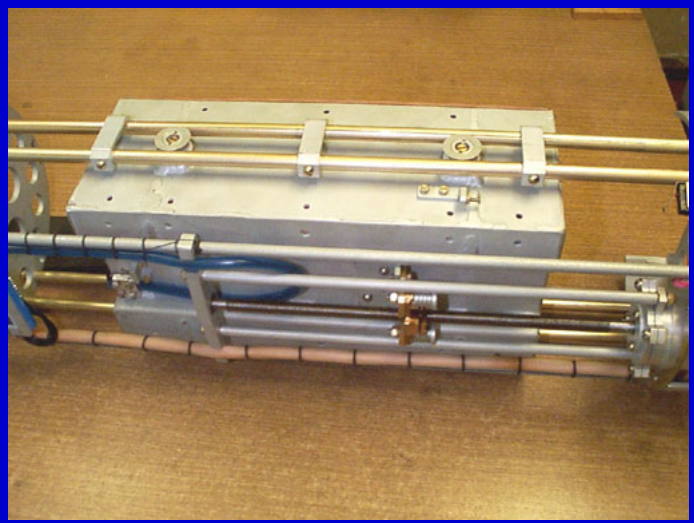
SOLAR AUV ENERGY TESTBED

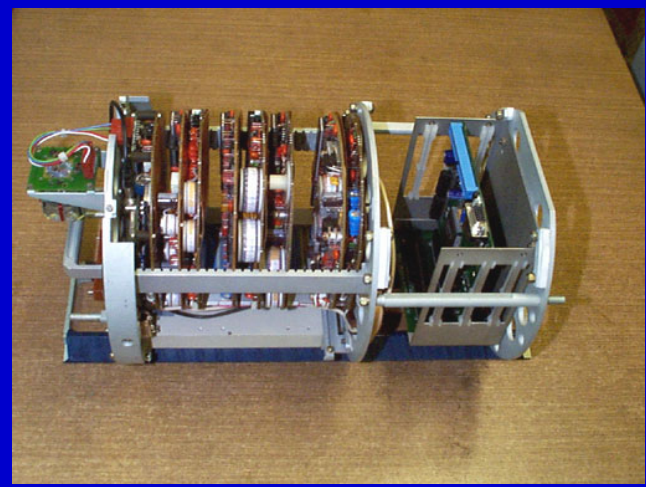


Modified Electronics and Battery System Hardware

Movable Battery Container for

- Low Energy Ascent
- Compensate for Antennas
- Surface Motion

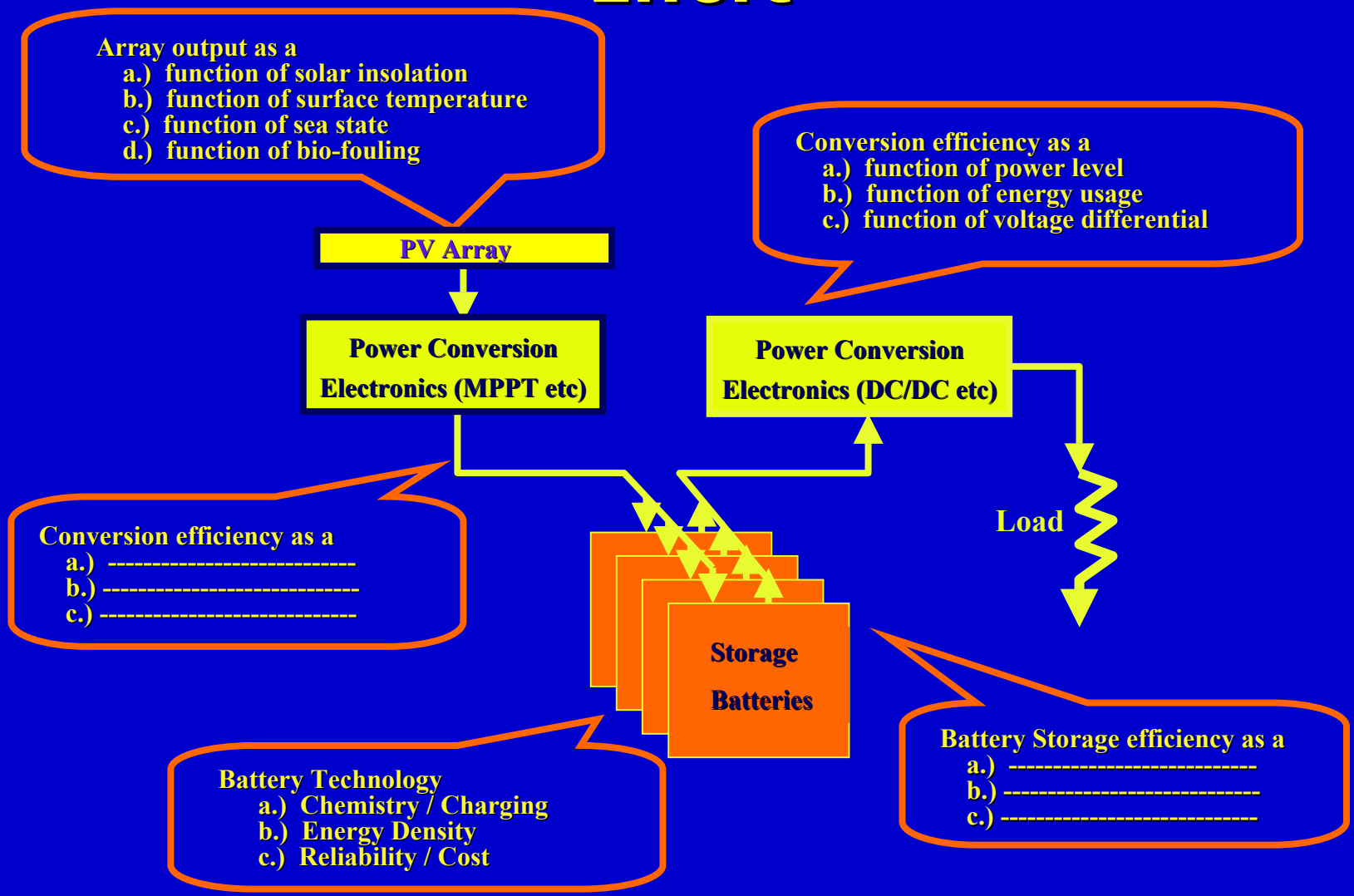




Modified PC Card Cage to Allow

- COTS Components
- Communications Subsystem

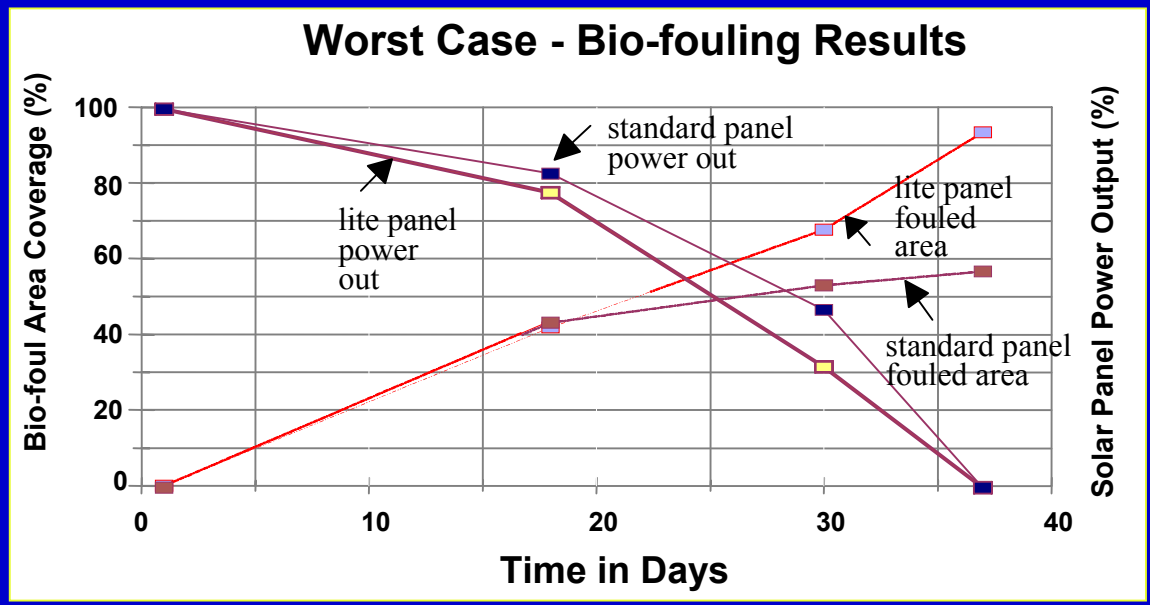
SAUV Energy System Modeling Effort



Parameters Affecting Energy System

- Communications
  - Energy Per Bit Received at a Remote Location
- Propulsion
  - Energy Expended / Km Traveled
- Mission Sensors
  - Energy Available for Data Acquisition
- Impact of the Environment on Energy System
  - Variability of Solar Insolation
  - Impact of Bio-fouling
  - Impact of Wave Motion

SAUV - Bio-fouling Experiments



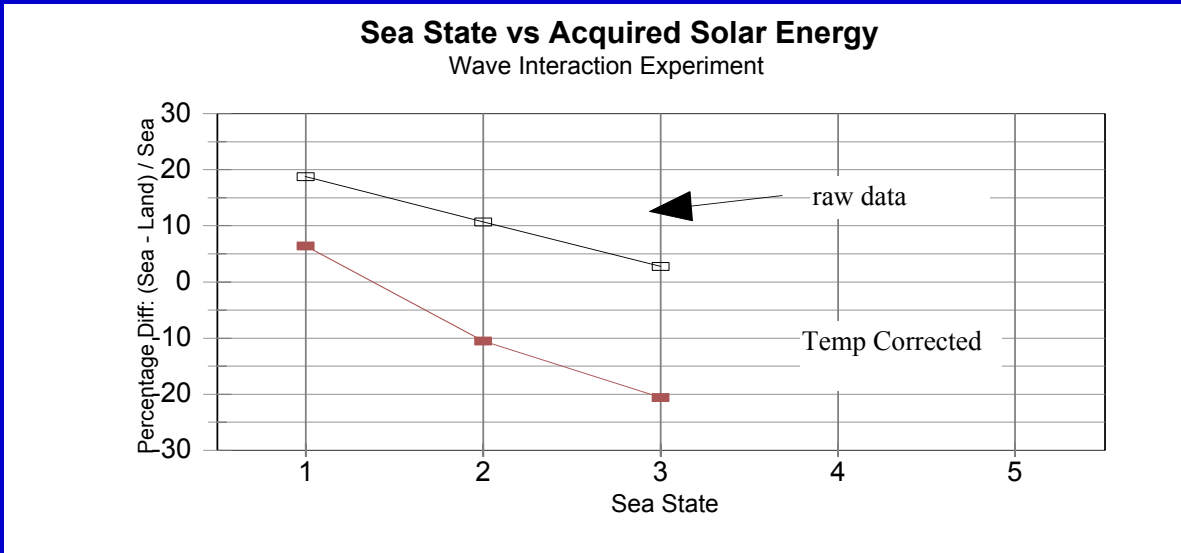
AFTER 18 DAYS:

Bio-foul Area Coverage about 42% (both standard and lite panels)
Power Output about 80% (both standard and lite panels)

AFTER 30 DAYS:

Bio-foul Area Coverage about 53% and power output about 47%(standard)
Bio-foul Area Coverage about 67% and power output about 32% (lite)

Energy Acquisition Correction Factors



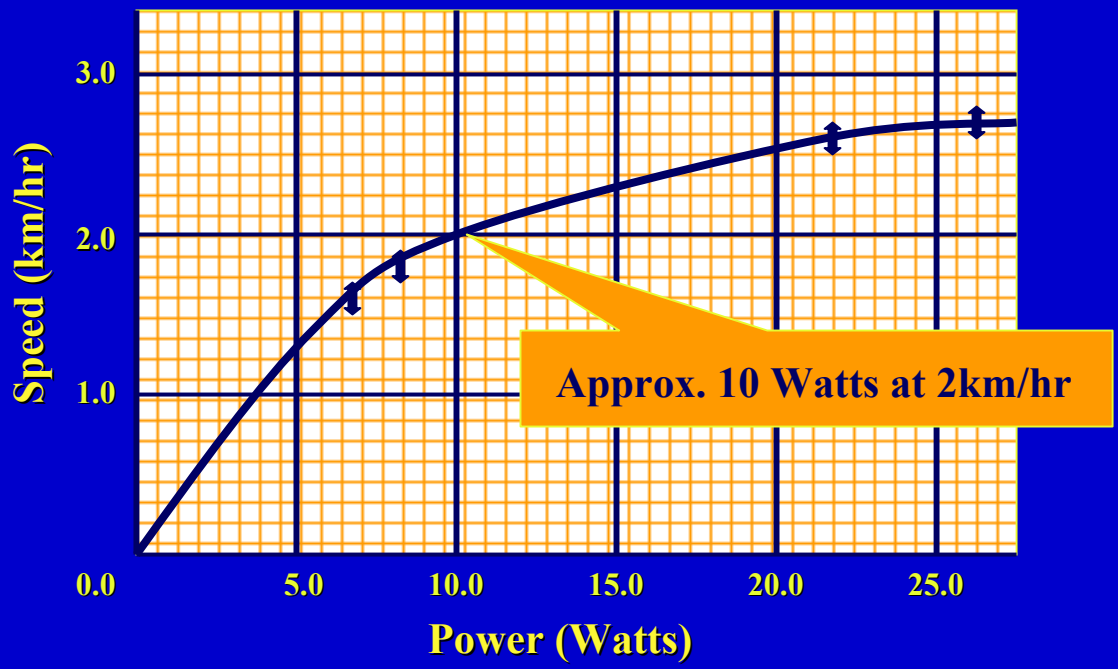
TEMPERATURE COMPENSATION FACTORS

1. Gas Gauge Charge Efficiency Compensation
2. Self Discharge Rate Compensation
3. Solar Array Panel Temperature

Battery Charging Algorithm on the EST

- MOSFET Switches Connect Batteries to Solar Array or Load
- Electronic Gas Gauge and Charge Controller (Bq2112) Monitors Battery Capacity and Determines Connection of Battery to Solar Array or Load
- "Normal Mode" Charges Batteries Between 20% and 80% Capacity
- To Prevent Memory Effects, Battery Is Fully Discharged and Charged Once Every 64 Cycles of Normal Charge Mode - "Charge Inaccurate Mode" - Restores Accurate Knowledge of Battery Capacity for Mission Ops Decisions

Test Results - Power vs. Speed



Goal: Extended Endurance of an AUV (Weeks to Months)

Effect of Energy Management Scheme on Total Range

	(theoretical)	(maximizes Transit distance)		
Total endurance	Scheme 0 (100%)	Scheme 1 (95%)	Scheme 2 (87%)	Scheme 3 (63%)
30 days	720 km	680 km	626 km	450 km
60 days	1440 km	1360 km	1252 km	910 km
360 days	8640 km	8110 km	7516 km	5440 km (guarantees 20km/day)

Note: SAUV operational scenario is defined as 2km/hr for 12 hrs/ day
120 Whrs for propulsion per day

An Example Data Acquisition Mission

Assume: Battery Storage efficiency 75%; Power Conversion efficiency 85%

Therefore a total energy efficiency 63%

Propulsion @ 2km/hr	11 hrs sampling 1 hr for orientation	120 Whrs
Computers	12 hrs @ 1 W, 12 hrs @ .25W	15 Whrs
Communication		25 Whrs
Mission Sensors	12 hrs @ 2.5 W	30 Whrs
System Sensors Actuators	12 hrs @ 1.5W 12 hrs @ .25 W	21 Whrs
Data Storage	2 hours active each day @ 1 W	2 Whrs
	Total Required Energy per day	213 Whrs

Energy Needed at Battery 334 Whrs;
Solar Insolation of 3340 Whrs/m^2/day 10 % PV efficiency

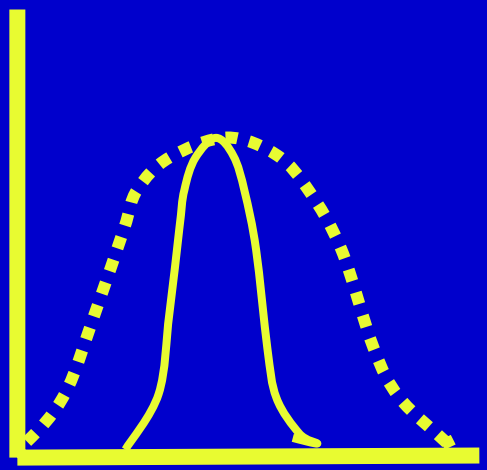
Solar Powered AUV 2002

Efficiency:	Component:
10	Array
85	Conversion
75	Battery
70	Motor
70	Propulsor
3.1%	TOTAL

Factors Affecting Efficiency

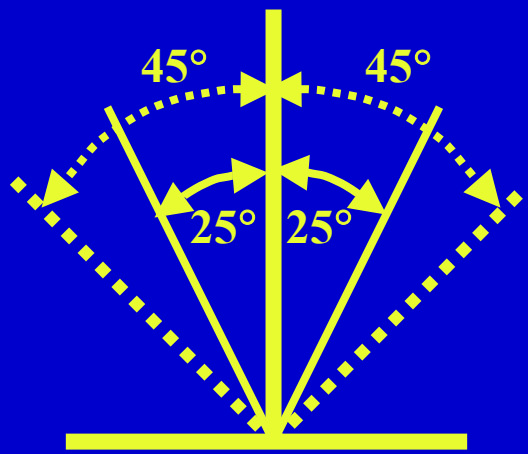
Current Capability ——————
Potential .....

Spectral Response

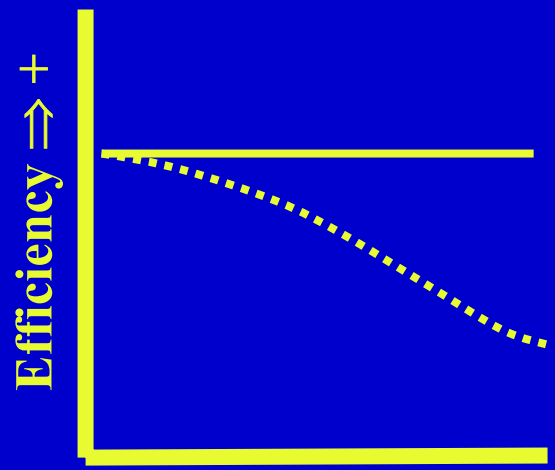


Wavelength 8

Angle of Incidence



Temperature



Temperature ⇒ +

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