Ultralight photovoltaic power and fuel tanks

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- Ultralight modular integrated photovoltaics mass and size
  - Module level description
  - Ultralight photovoltaic specific power on Mars
- Fuel and tank mass and size

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Large Scale Space Solar Power: Specific Power

SPS	USEF	JAXA	ESA	Alpha	**Caltech**
W/kg	41	98	132	33	**2000- 6000**
Max size for deployment	100 m x 95 m	3.5 km	15 km	6 km	**60 m x 60 m**

Current State of Art

- Off-the-shelf PV and power components

Watts on ground/kg in space

Ultralight Approach

- Innovate to develop science and technology for a lightweight, high-performance modular system; assume *current* launch costs

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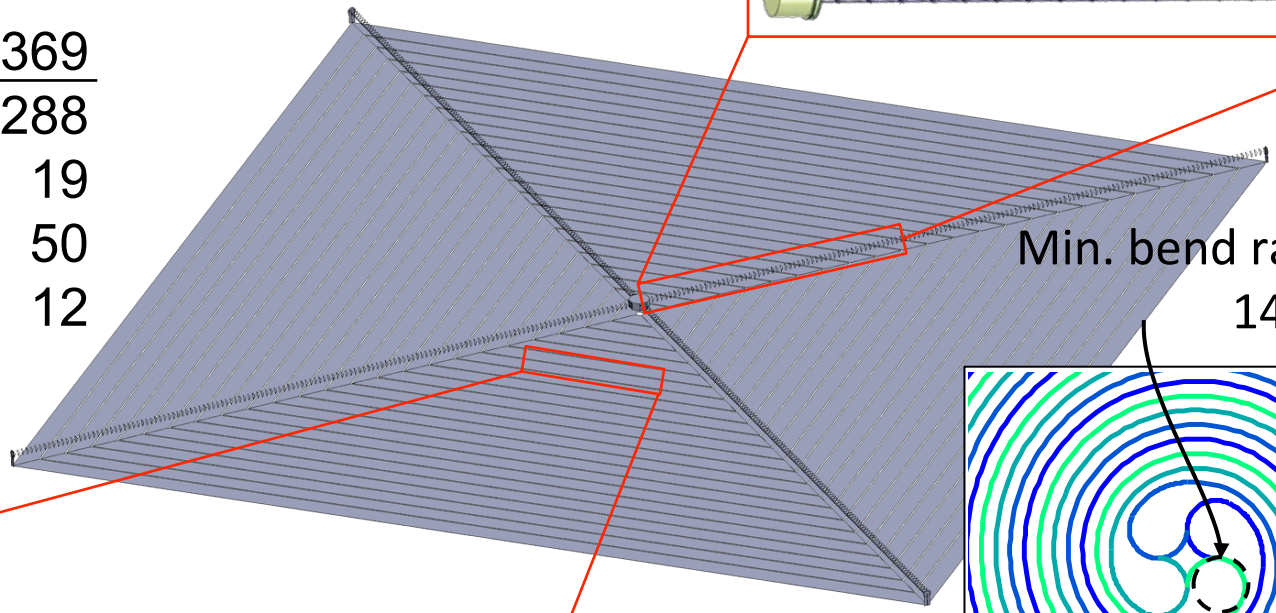
Module Design Summary

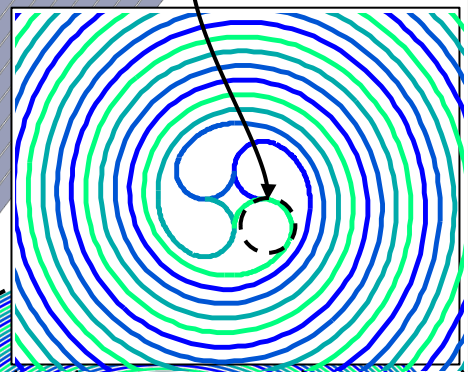
60 m x 60 m square architecture.
Designed for tile rotation <1° under SRP.

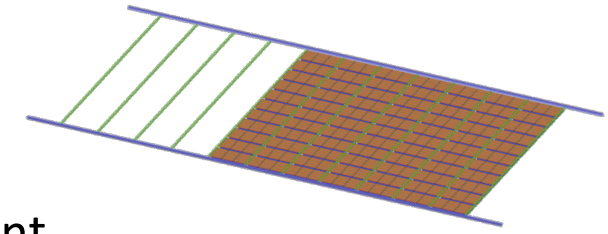
Mass (kg)	369
Tiles (@80 g/m^2)	288
Strip structure	19
Hub	50
Booms	12

Booms:
4 × coilable CFRP trusses
42 m long, ~1.5 kg each, ATK



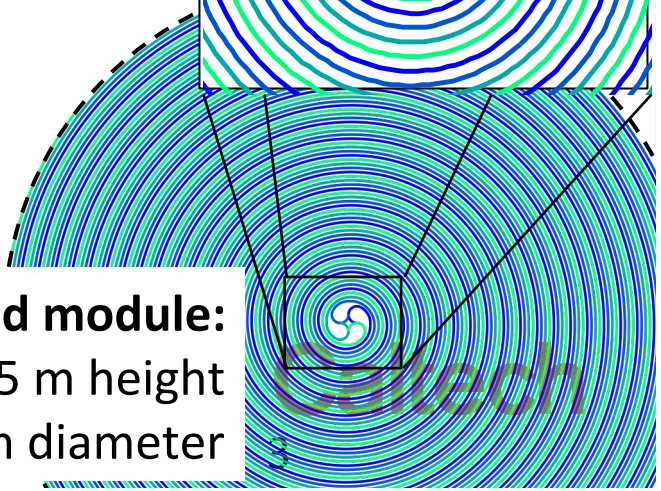
Min. bend radius
14 mm





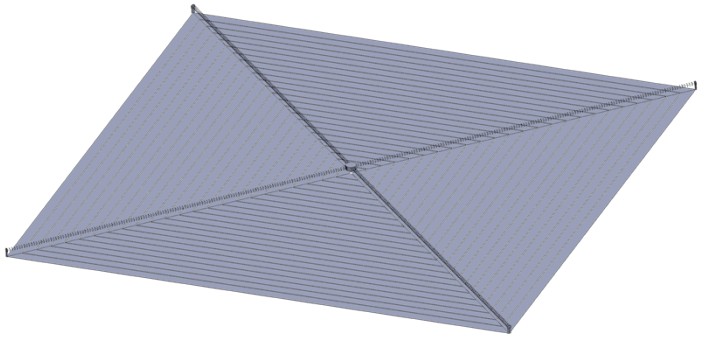
Strips:
1.5 m wide
20 per quadrant
CFRP TRAC longerons (2 x 64 µm thick tape springs, max stowed strain < 0.5%)

Stowed module:
1.5 m height
0.926 m diameter



Module Power on Mars

Space: 4.7 MW at AM0 (1330 W/m2)



Daily average on Mars, no dust: = 529 kW
(147 W/m2 , from Dave)

Daily average on Mars, dust storm: 118 kW =
(33 W/m2 , from Dave)

Module weight = 370 kg

Specific power on Mars:

529/370 = 1.4 kW/kg (no dust)

118/370 = 318 W/kg

Weight of fuel tanks

- Data derived from rocket motor tank specs
- Tank wall thickness:
  - Falcon 9 Heavy: 4.7mm (reusability)
  - Space Shuttle external tank and Atlas rocket ('old school'): 2.5 to 10 mm
  - Centaur upper stage: 0.36 to 0.41 mm
  - Saturn V first stage: 4.32 to 6.45 mm
- Tank volume and size:
  - Saturn V:
    - 43 m tall and 10 m diameter
    - 770,000 liters of kerosene and 1.2 million liters of liquid oxygen
- Tank and fuel weight (Saturn V):
    - (314 m2 x 0.003 m = 0.94 m3) x 2830 kg/m3 = 2600 kg 2.6 metric tons
    - 770,000 liters of kerosene and 1.2 million liters of liquid oxygen: Assume it's all oxygen (1.97 million liters of liquid oxygen)x(1.14 kg/l) = 2.25 million kg = 2,250 metric tons of liquid oxygen