REhnu, LLC

Roger Angel
David Follette
Peter Strittmatter

http://www.rehnu.com

GOALS

- Reduce Fossil Fuel Use – CO_2 in Atmosphere – Slow Global Warming

- Exploit Large Source of "Free" Energy – especially in Arizona

- Accomplish this at Giga-watt scales at a capital cost that is economically competitive without subsidies

- Develop Technology to Achieve the Capital Cost Goal

Capital Cost < $1.0/ Watt

REhnu

Solar Electrical Power

Main Elements are:

- Generation
- Storage
- Distribution

Arizona (Mirror Lab) program is focused only on Generation using Concentrator Photo-voltaics. It is aimed at Utility Scale Generation (Gigawatt-scale)

REhnu

Background/Costing Realities

Large Collecting Area needed - true for all solar approaches – incident energy density low (1KW/m^2)

High concentration (10^3) to make optimum use of efficient triple junction cells - >35% currently commercially available. *(Only modest gains remain from PV efficiency –may get to 50%)*

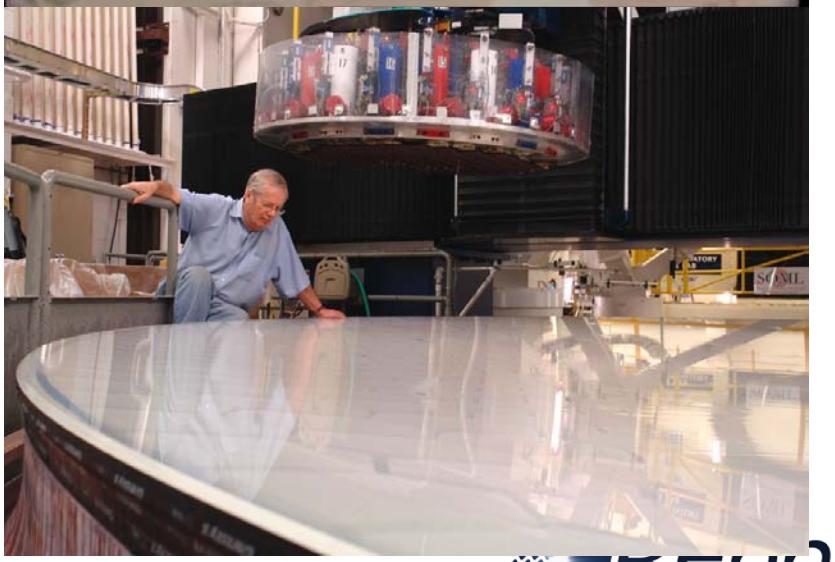
High concentration also implies low cell area and hence low cost/cell (currently ~ $0.16/w).

Capital goal requires that the 10^3 concentrator cost s < $0.84/w.

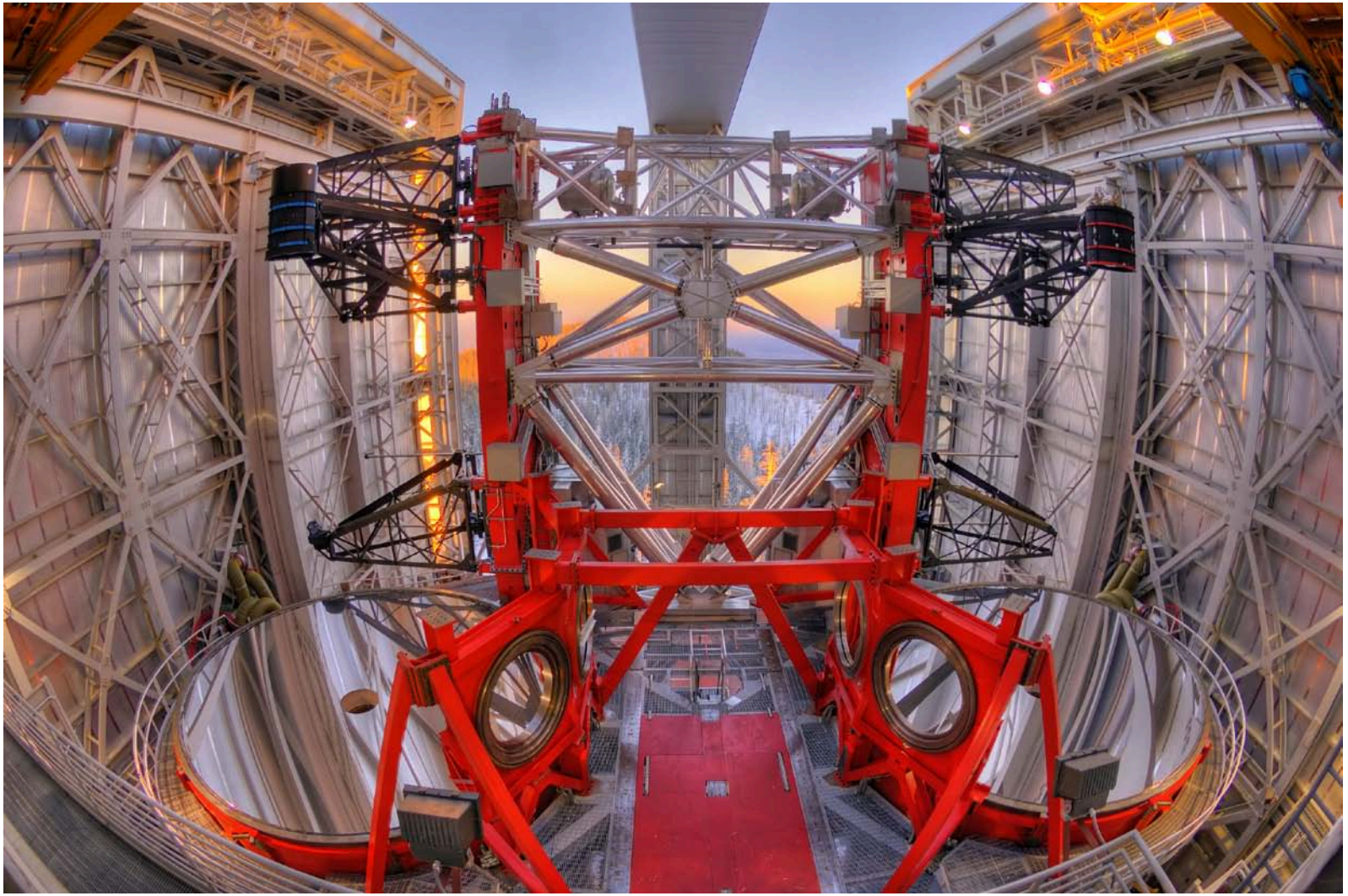
Achieving this is a matter of mirrors and structure – just like telescopes. But $/$m^2$ must be ~ 10^4 less. (Telescope ~ $$10^6$ /m^2 Concentrator ~ ~ $$10^2$ /m^2 to meet goal)

REhnu

The Mirror Lab/TelescopeHeritage



The Large Binocular Telescope
Mirrors (8.4m) from the UA Mirror Lab



REhnu

Thw Mirror Lab/Telescope Heritage

Adaptive Secondary Mirrors

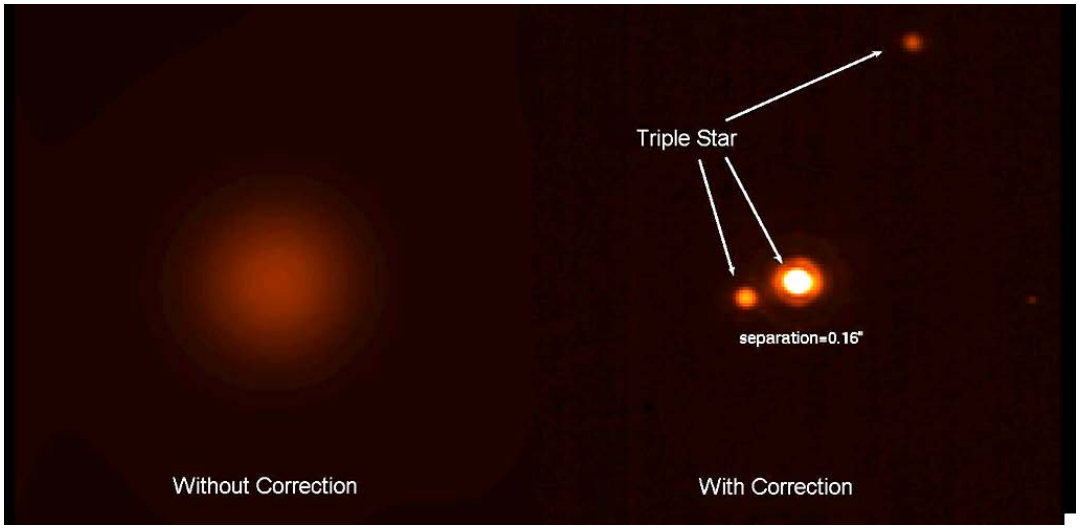
- 1.5 mm thick
- 0.9 m diameter
- Magnetic levitation support developed by Piero Salinari and colleagues at Arcetri
  - 632 actuators
  - 1 milli-sec response time
  - Set to any absolute shape

REhnu

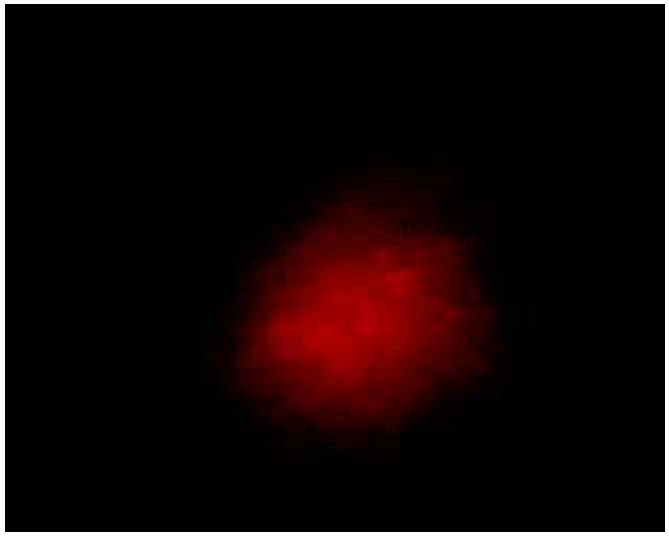
LBT Adaptive Secondary
First Results

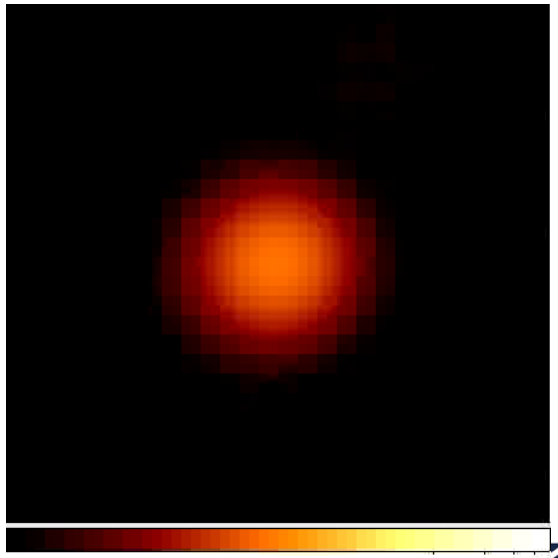
HD 124085

K0, R=7.5 m
I=6.9, H=5.8
Seeing 0.6″
Strehl Ratio
H 65%...73%
H-Band Scale
10mas/pix



3.2"





REhnu

Telescopes for Solar Energy

Structures made of glass and steel

Because steel is priced per kilogram, low cost structure implies light weight structure

Structure must remain stiff enough to maintain adequate pointing and to survive in storms

Concentration ~10^3 requires 2-d paraboloid. Needs to be made inexpensively.

Solution : Use float glass, made in vast quantities in 3m x 3m plane sheets for architectural purposes. Typical production rate is ~1 sheet /10 seconds . Need to slump to desired shape.

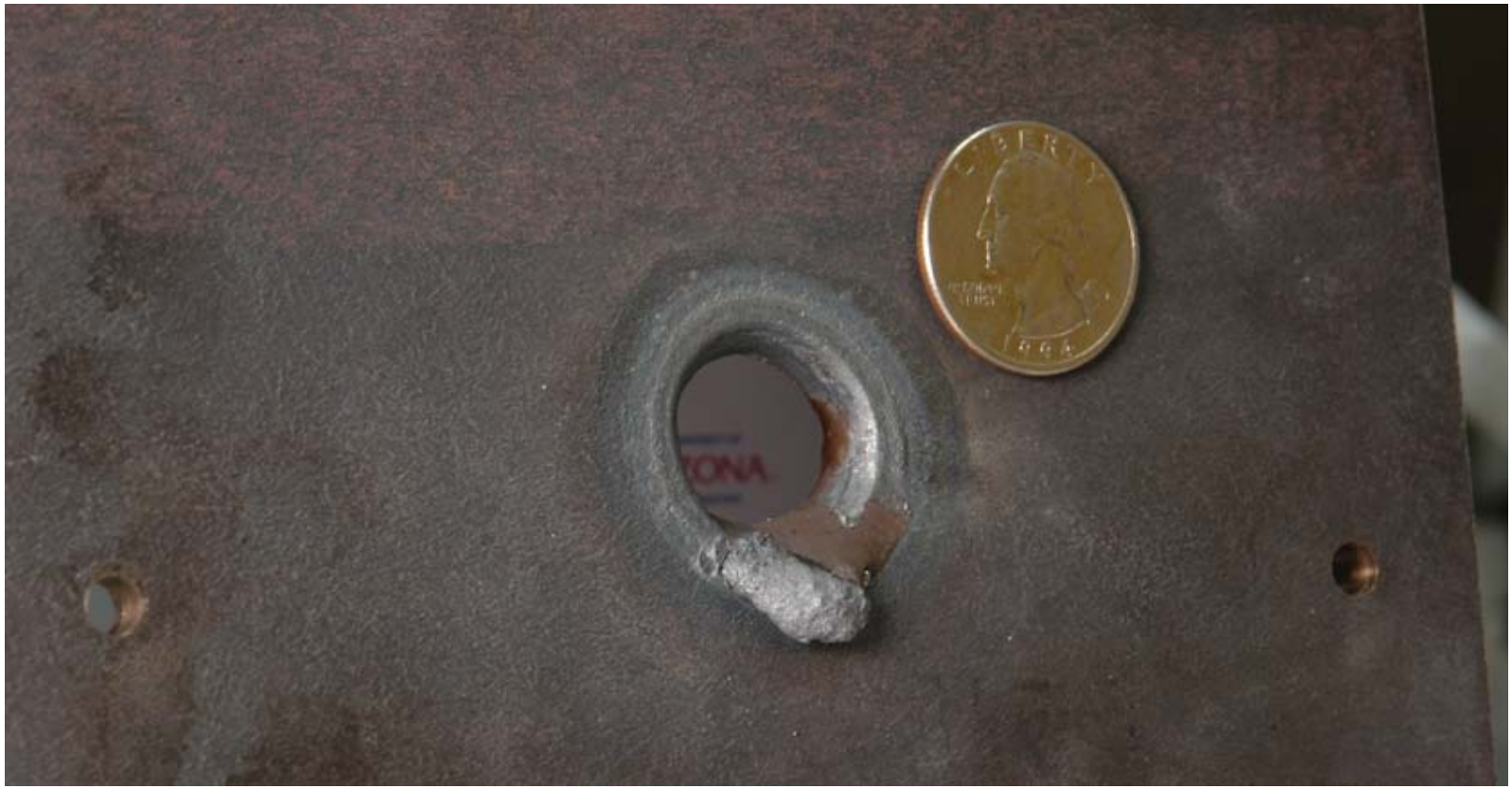
REhnu

Initial Efforts

The first 3m concentrator made up of slumped and silvered panels mounted on an old radio antenna. Present are (L-R) UA President Shelton, Tucson Congresswoman Gabrielle Giffords, Roger Angel

Hot Stuff

Results with the 3 m concentrator telescope. A 15 sec solar exposure on 6 mm thick steel resulted in a hole the size of a quarter. The experiment demonstrated that slumping produced sufficient figure accuracy. It also demonstrated the need to protect PV-cell from excessive heating.



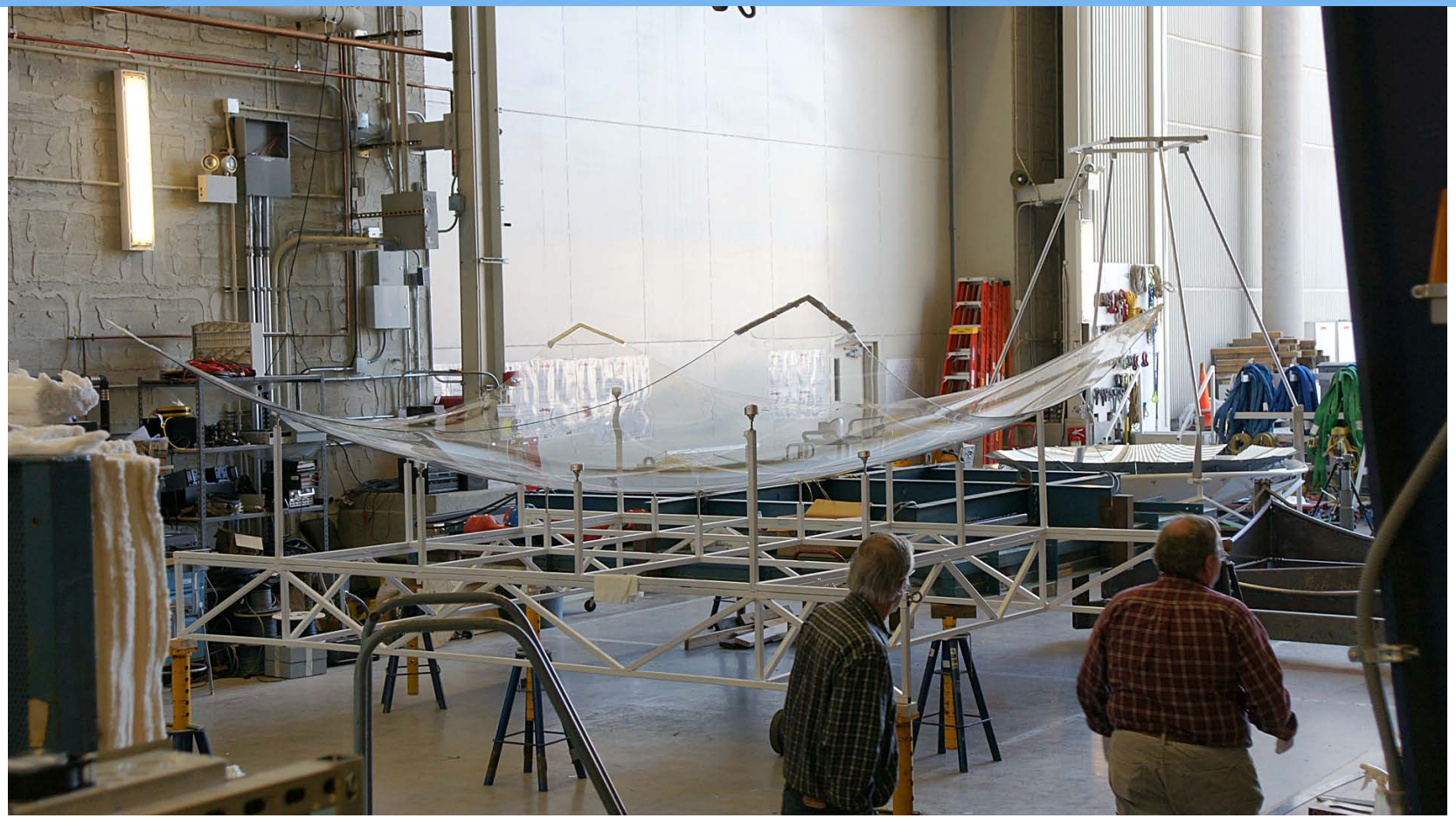
REhnu

Slumping/Shaping the Float Glass Sheets

The prototype slumping furnace in the UA Mirror Lab. In production, the float glass sheets need to be slumped at same rate, 1 per 10 seconds, as they are produced. At that rate can build capacity of ~7.5 Gigawatts per year per float glass factory.

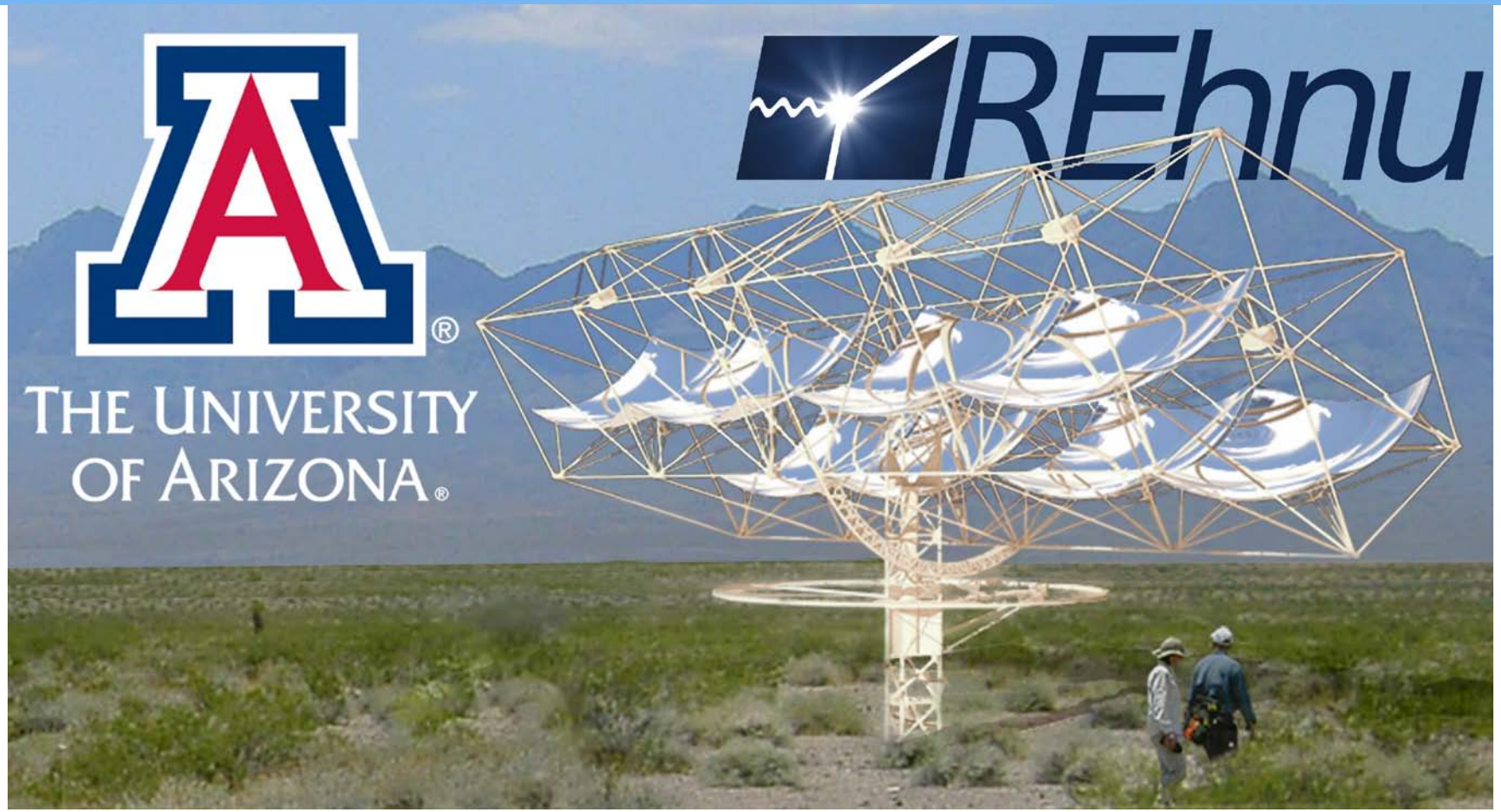
REhnu

Early Slumping Products



First slumped 3m x 3m reflector. Process still under development. Also need efficient means of backside coating with silver and applying protective covering. Individuals shown are Roger Angel and Materials Scientist, Blane Olbert.

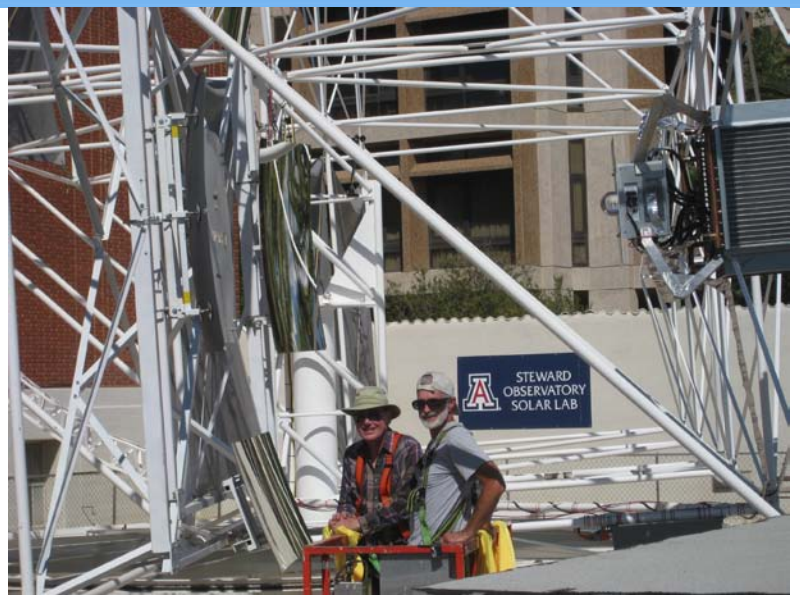
The Tracker Telescope Concept

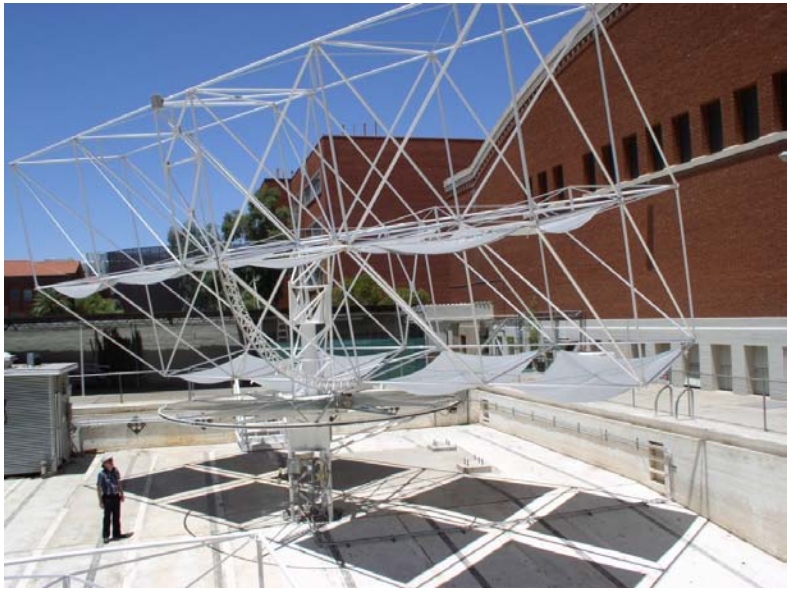


Advantages; Stiff: Low mass: Simple tracker mechanism: Minimal environmental impact: 8 float glass sheets: Low self-shadowing in array “farm”; Capacity 20KW

REhnu

Tracker Current Status

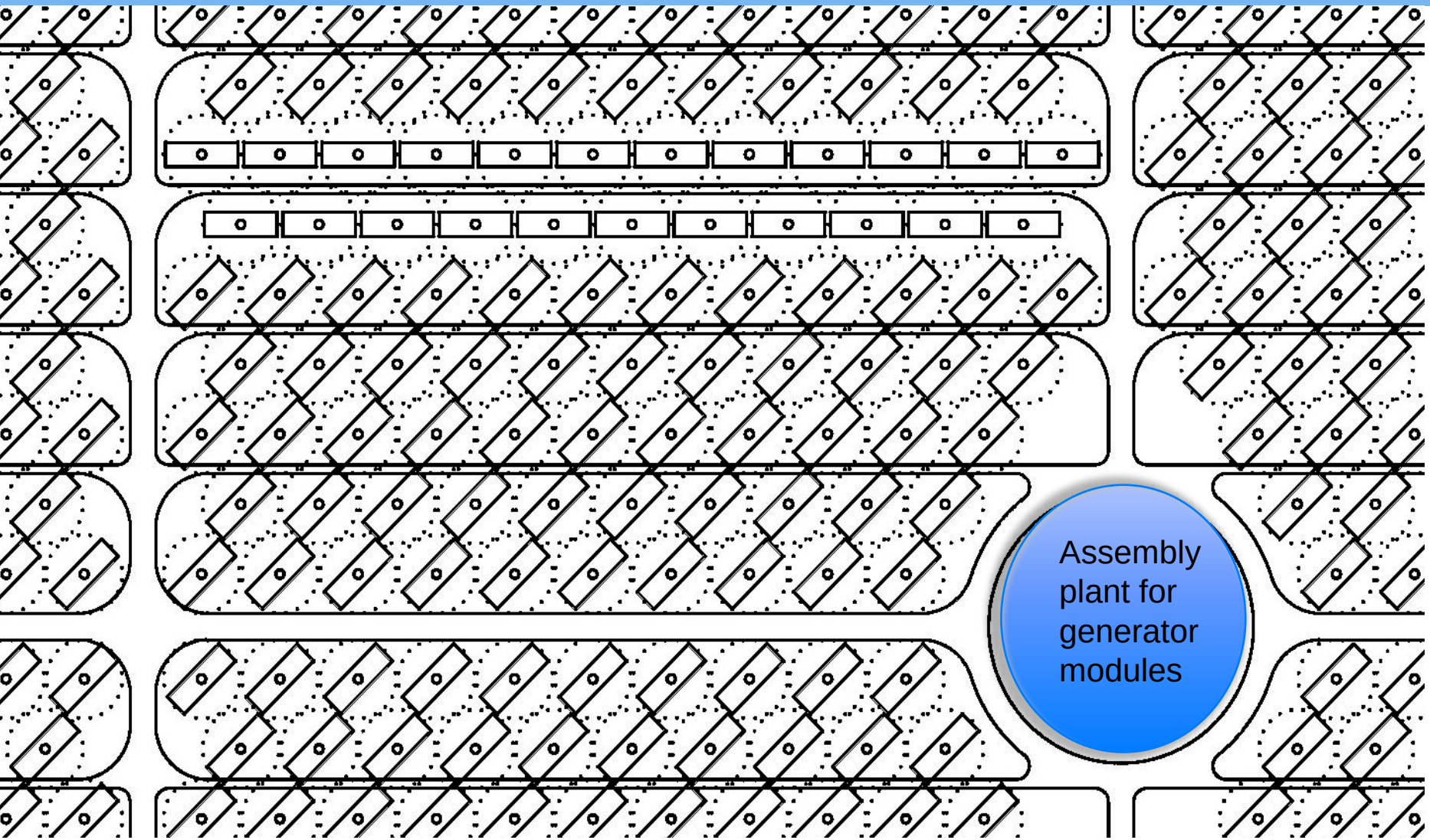




Tracker has worked for several months
Maintains pointing to within 0.1 degrees
Has survived summer “monsoon” storms
Currently has canvas sheets to provide simulated reflectors for wind testing purposes

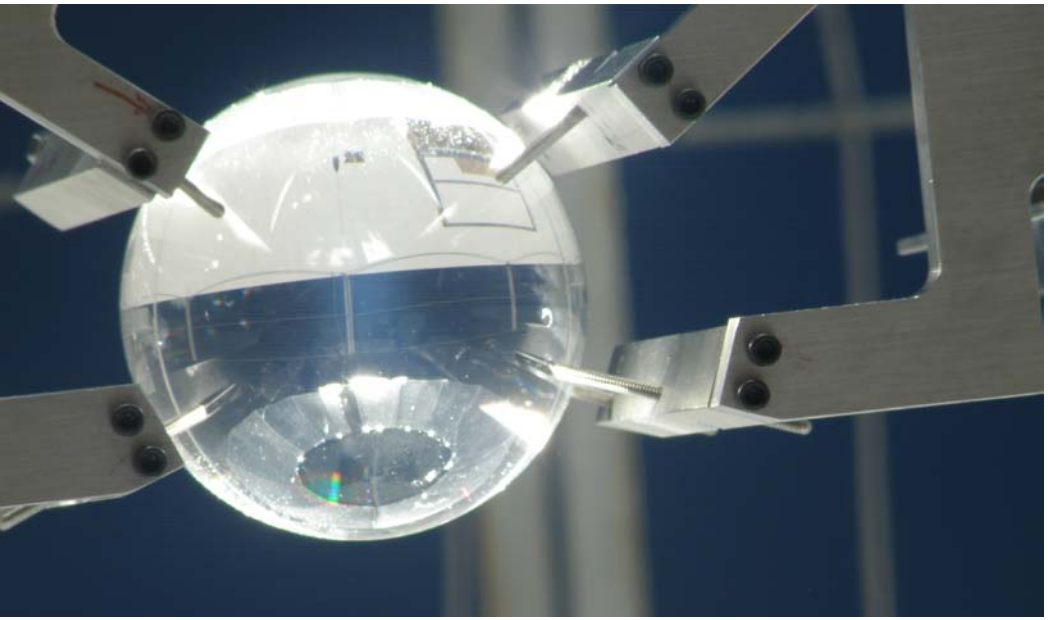
REhnu

Generator Farm: Modules will be assembled at a central plant and transported to there final location



REhnu

The Receiver/Converter Unit



The sunlight from each dish is focused in the center of a sphere of pure fused silica - the blue glow is Rayleigh scattering

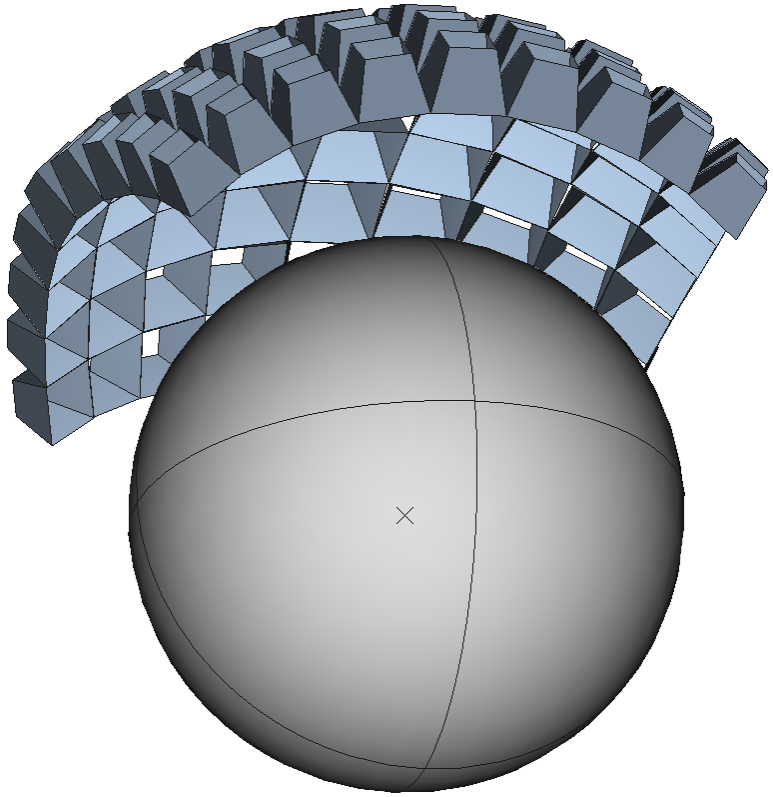


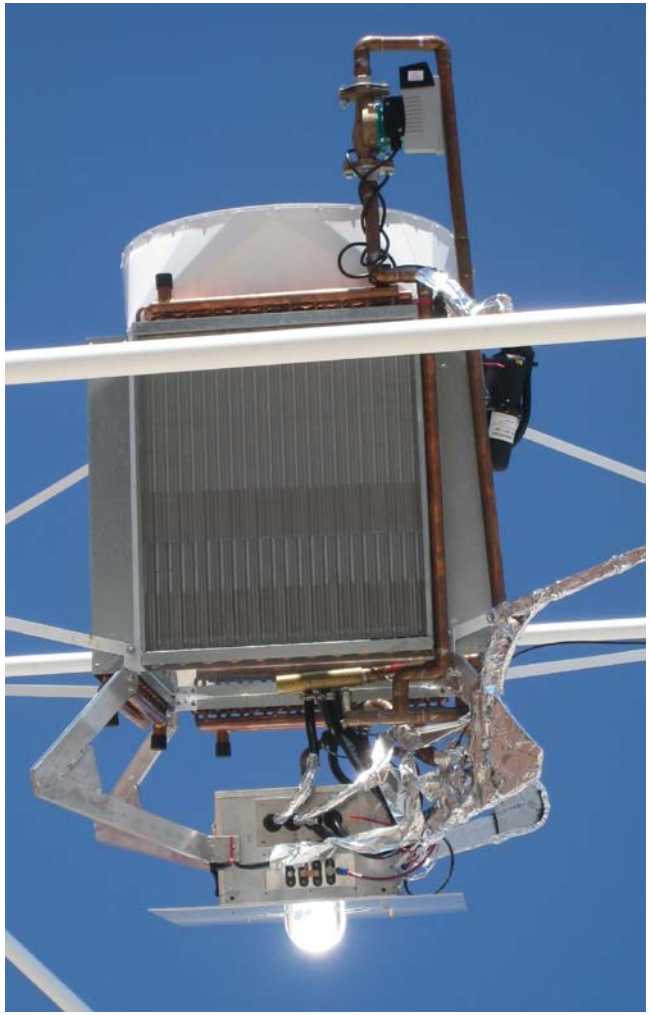
Image of 3 m square reflector feeds many cells, all with same flux. Note, the individual concentrator elements,

REhnu

Receiver technology

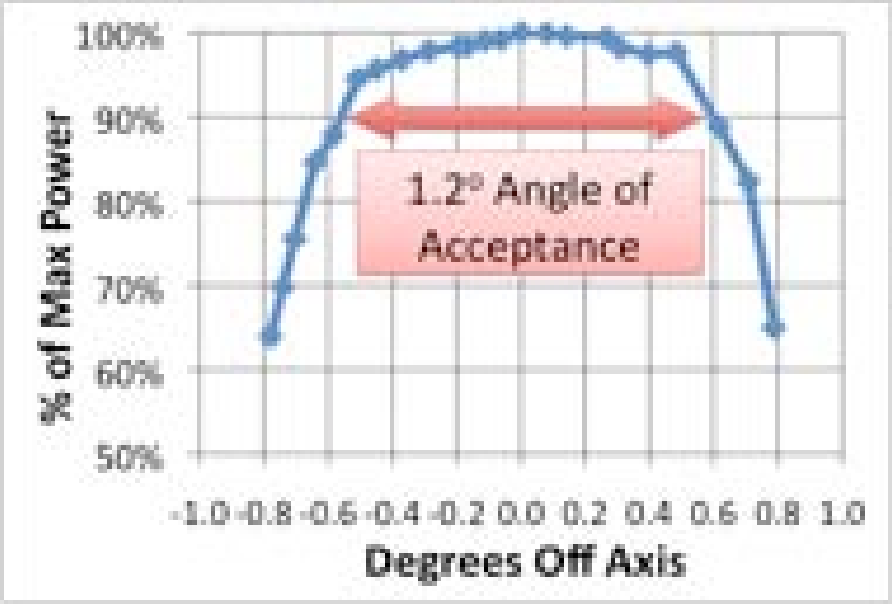
36-cell mock-up with crystal ball

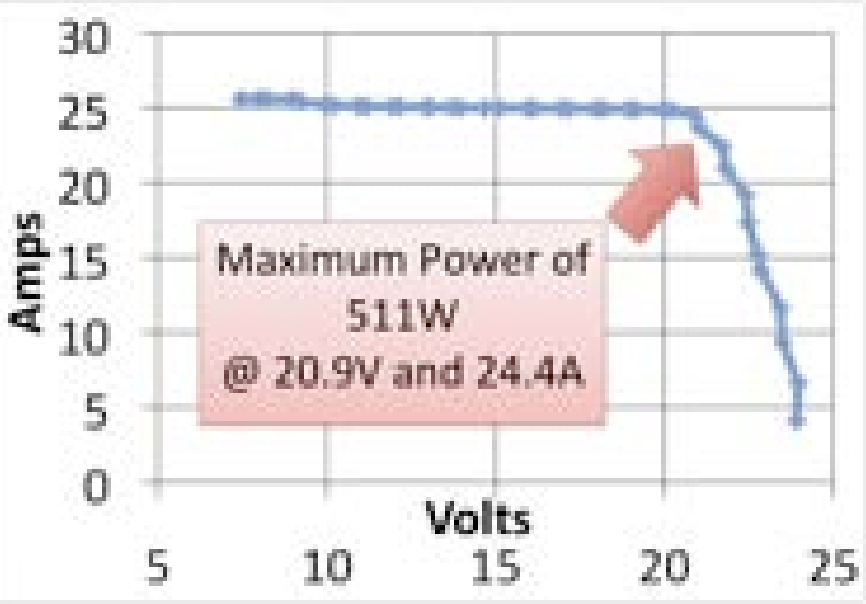
On-sun at 1000x



REhnu

Real performance data



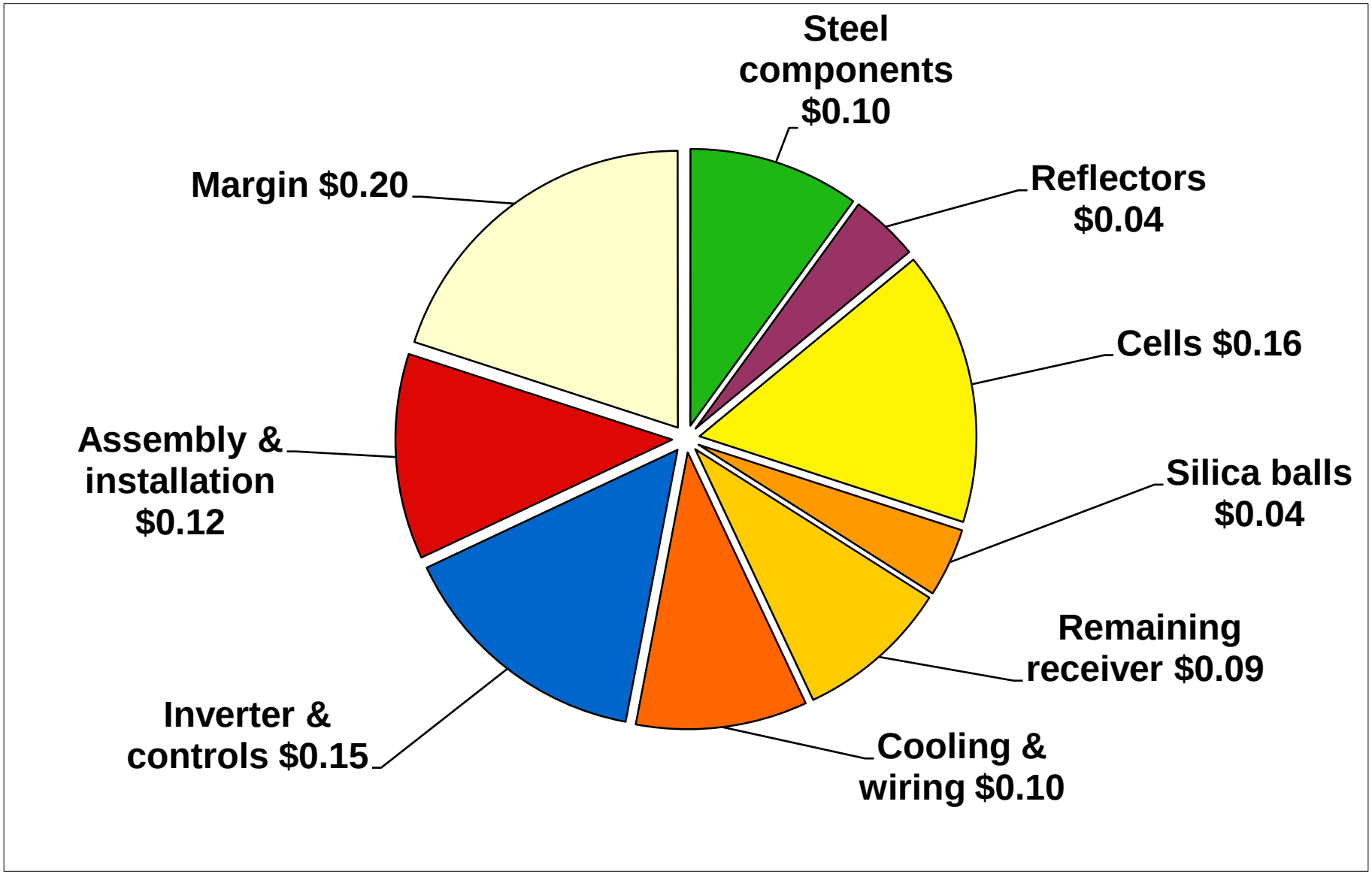


These are data recorded with the 8-panel system feeding 8 cells. The left hand diagram shows the insensitivity of the system output to pointing error with an acceptance angle of 1.2 degrees, large compared to the pointing accuracy of 0.1 degrees. The right hand panel shows the output of the system producing approximately 500W which represents an end-to-end efficiency of 24.7 percent. The next step is to feed all 36 cells with a full 3m square reflector.

Note that the increase in temperature of the cells was less than 20 ^{0}C using a closed liquid cooling system to air.

REhnu

Can we achieve the $1/Watt Goal



Automotive Credibility

- If generator units can be built at the same cost per kg as a pickup truck, the power cost will be $1.60/watt.
- Generators are much simpler than pickups, so $1/watt is credible.

REhnu

REhnu
gigawatt scale solar

Summary

Can competes in cost with fossil fuel without subsidy

Designed for mass production. Needs Automotive industry approach.

Environmentally friendly.

REhnu