PROTEAS
Solar TRIgeneration
ENERGY INDEPENDENT GREEN BUILDINDS

HELIOTRON ENERGY SA

November 2011

PROTEAS SHORT HISTORY

- PROTEAS has been invented, patented and developed by Mech.-Electrical Engineer NTUA Alexandros Christos Papadopoulos.
- PROTEAS has won the First Prize of Technology from the Intellectual Property Organization (OBI) in 2004.
- It has been developed in the frame of one European and two National R+D Programs with a total value of 4,6 Million Euro
- Patents are issued or pending in Europe, China, India USA and Australia.
- A Commercial Prototype has been developed and is going to undertake measurements and Certification

Green Building Incentives

- In Greece the New PV Law is voted
- All Buildings over 1.000m2 must be equipped with Solar Energy
- For up to 10KW on House-Roofs a Feed-In Tariff of 0,55€/KWH/25Years
- In Cyprus 55% Grant till 120.000€
- In other 10 European Member States Incentives in form of Grants or Feed-In Tariffs

Prototype Solar TRIgeneration Unit

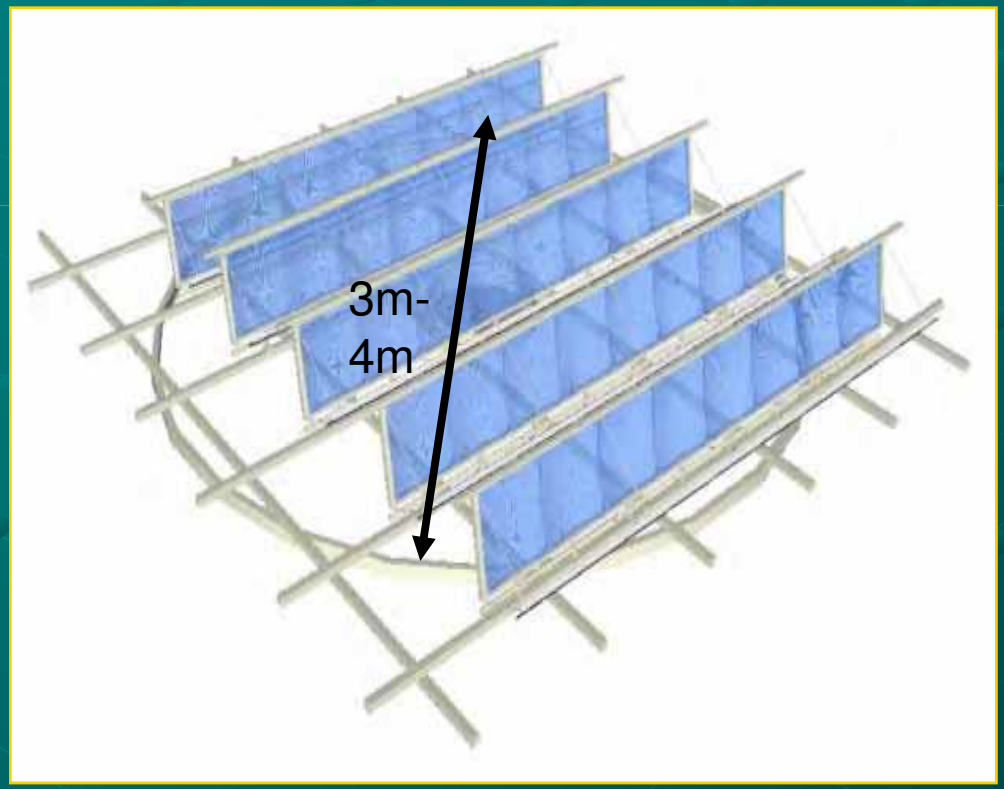
Ammonia Heat Pump and Storage

The System Characteristics

- Solar TRIgeneration System

  Production of: Electrical, Two-level Thermal and Cooling Power

  Typical Unit: 1000Wp | 250-500Lt Hot Water | 8000-16.000BTU | 500-1000Lt Warm Water



- Innovative Optical System
- Concentrating PV Cells
- Advanced Absorption Chiller
- Metal Construction
- Tracking System
- Control System

Typical Green Building Feasibility

- We consider a Typical 200m2 House in Attica Area
- For full coverage of its needs in Air-Condition and 80% in House Heating we take 10,0KWp of Solar TRIgeneration
- The cost of the system installed will amount to about 10x5.000= =50.000€
- State Support: Feed-In Tarrif 0,55€/KWH for 25 years
- Substituted House Components: (Central Heating and Air-Conditioning)*: 200x3.000x0,02= 12.000€
- Substituted 1(till 8) Solar Collectors: 1.600€
- Other Substituted House Components:3,0KW UPS: 600€
- Total Value of substituted House-Components: 14.200€
- Cost for a New House:52.000-14.200= =37.800€
- Cost for an Existing House: 52.000= =52.000€

Typical Green Building Annual Yield

- The expected Annual Energy Yield of a Typical 200m2 House in Attica with a 10,0KWp Solar TRIgeneration Facility is as follows;
- Solar Electricity: 10,0KWp x 2.000KWH/KWp.Y= 20.000KWH/Year
- Substituted A/C Electricity: 10,0KWpx2.000 = 20.000KWH/Year
- Hot/Warm Water (80/60 Deg Celsius): 30.000-40.000KWHth/Year
  or Equivalent Heating Oil (pool/house heating): 3.000-4.000Kg/Year
- Production of Green Certificates:10,0 x 6,0T/KWp = 60TonCO2/Year
- Value of Electricity: (20.000)x 0.55= 11.000€/Year
- Value of A/C + Heat-Pump Electricity: (20.000)x 0.12 = 2.400€/Year
- Value of Heat: (3.000-4.000)x0.75€/KgOil= =2.250-3.000€/Year
- Value of Green Certificates: 60 x 30€/TonCO2= 1.800€/Year
- Amortization time (New Houses)*: 37.800/15.650 2.415 Years
- Amortization time (Existing Houses)*: 52.000/17.450= 3,323 Years
- Hotels are the ideal users as they can utilize fully all energy yield
- *Green Certificates not taken into consideration (they can be taken into considered by big consumers like Hotels or the State)

Typical Green Building Feasibility

- We consider a Typical 200m2 House in Cyprus
- For full coverage of its needs in Air-Condition and 80% in House Heating we need 8,0KWp of Solar TRIgeneration
- The cost of the system installed will amount to 8x6.000=48.000€ + 4.000€(Aux. Boiler)= 52.000€
- State Grant: 48.000x0,55= 26.400€
- Substituted House Components: (Central Heating and Air-Conditioning)*: 200x3.000x0,02= 12.000€
- Substituted 1(till 8) Solar Collectors: 1.600€
- Other Substituted House Components:3,0KW UPS: 600€
- Total Value of substituted House-Components: 14.200€
- Cost for a New House:52.000-(26.400+14.200)= 11.400€
- Cost for an Existing House: 48.000 - (27.000)= 21.000€

Typical Green Building Annual Yield

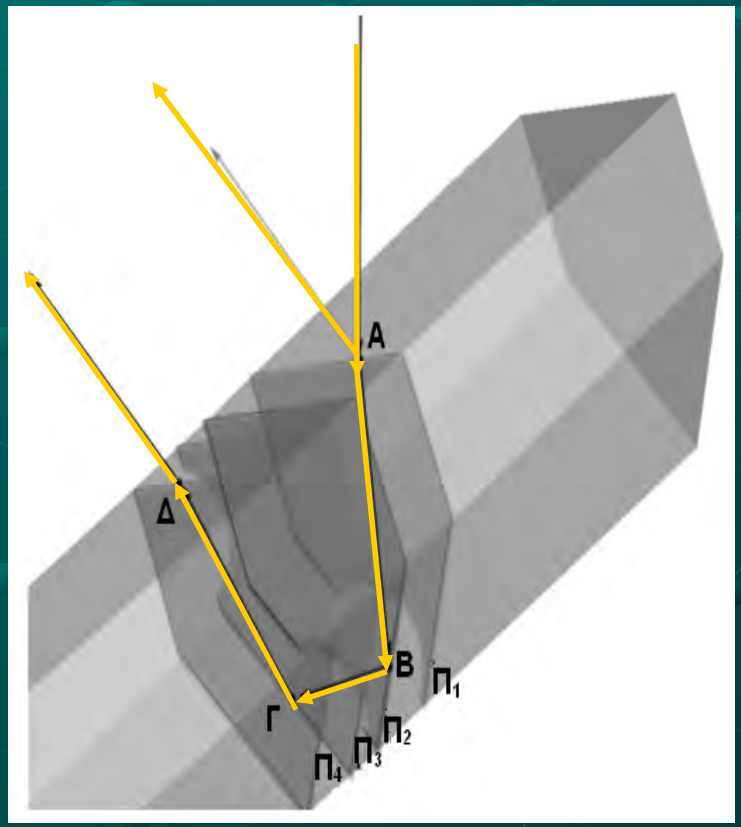
- The expected Annual Energy Yield of a Typical 200m2 House in Cyprus with a 8,0KWp Solar TRIgeneration Facility is as follows;
- Solar Electricity: 8,0KWp x 1.800KWH/KWp= 14.400KWH/Year
- Substituted A/C Electricity: 8,0KWpx1.200 = 9.600KWH/Year
- Hot/Warm Water (80/60 Deg Celsius): 24.000-40.000KWHth/Year
  or Equivalent Heating Oil (pool/house heating): 2.400-4.000Kg/Year
- Production of Green Certificates: 8,0 x 5,0T/KWp = 40TonCO2/Year
- Value of Electricity: (14.400+9.600)x 0.12= 2.880€/Year
- Value of Heat: (2.400+4.000)x1/2x0.75€/KgOil= 2.400€/Year
- Value of Green Certificates: 40 x 30€/TonCO2= 1.200€/Year
- Amortization time (New Houses)*: 11.400/5.280 2.16 Years
- Amortization time (Existing Houses)*: 21.000/5.280 = 3,98 Years
- Hotels are the ideal users as they can utilize fully all energy yield
- *Green Certificates not taken into consideration (they can be taken into considered by big consumers like Hotels or the State)

Comparison with Conventional PV

- 8,0KWp Conventional PV on a 200m2 House in Cyprus
- Annual Energy Yield: 8,0x1.600= 12.800KWH/Year
- Cost of 8,0KWp Conventional PV: 8,0x4.000= 32.000€
- State Grant: 32.000x0,55= 17.500€
- Value of PV Electricity: 12.800x0,12€/KWH*= 1.536€/Y
- Production of Green Certificates:12.800x0,9= 11.520Kg/Y
- Value of Green Certificates: 11,52Tx 30€/T= 345,60€/Y
- Substituted House Components New House: None
- Substituted House Components Existing House: None
- Amortization time : (32.000-17.500) / 1.536= 9,44Years
- Compared with 2,16 Years (for New House) or 3,98 Years (for Existing House) of Solar TRIgeneration
- Comparison of Green Certificates:346€/Year /1.200€/Year

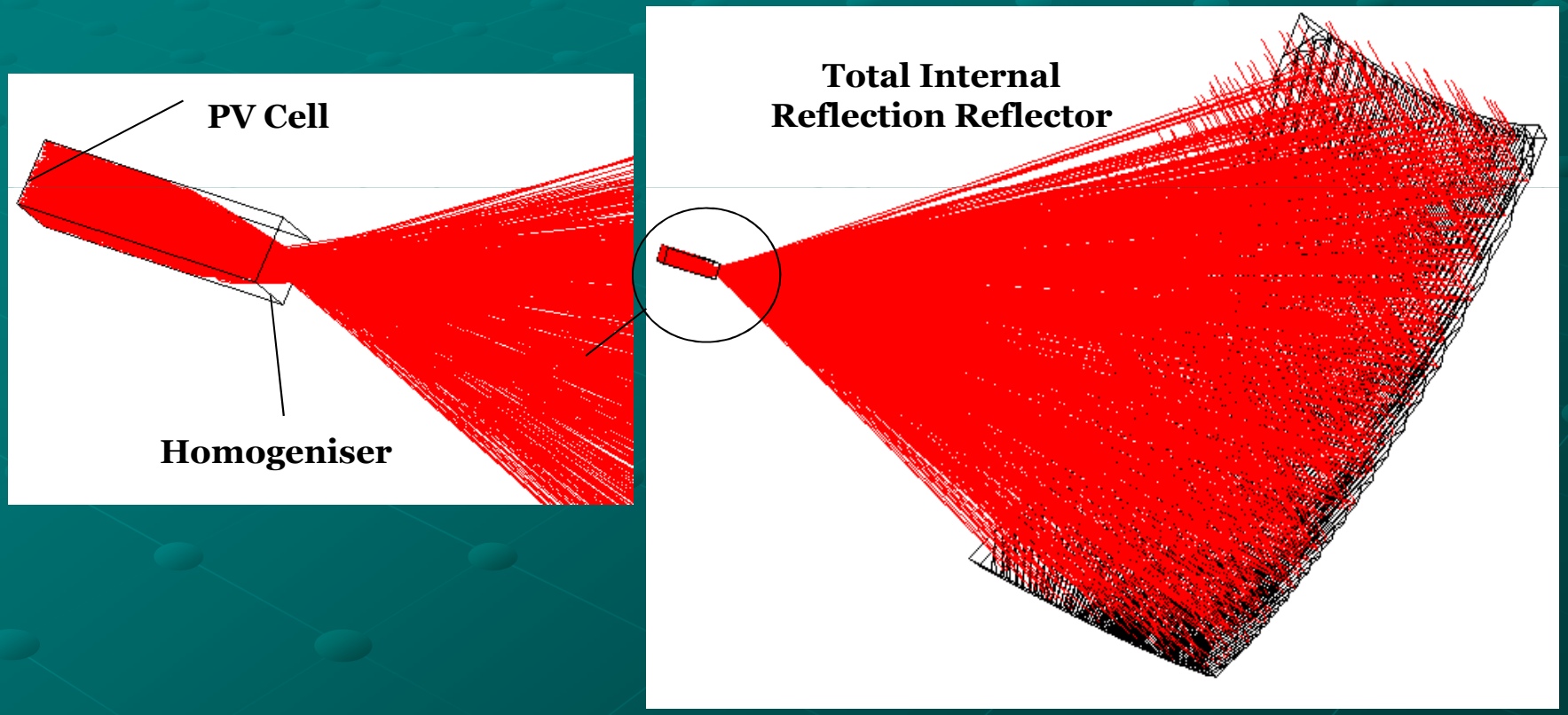
Total Internal Reflection Prisms

- Constructed as a Total Internal Reflection Reflector with Corrected Orthogonal Prisms
- High Concentration Point Focus 1:7500 through Total Interrnal Reflection of Sun-Light
- Material: Water-Clear Glass or PMMA or Polycarbonate

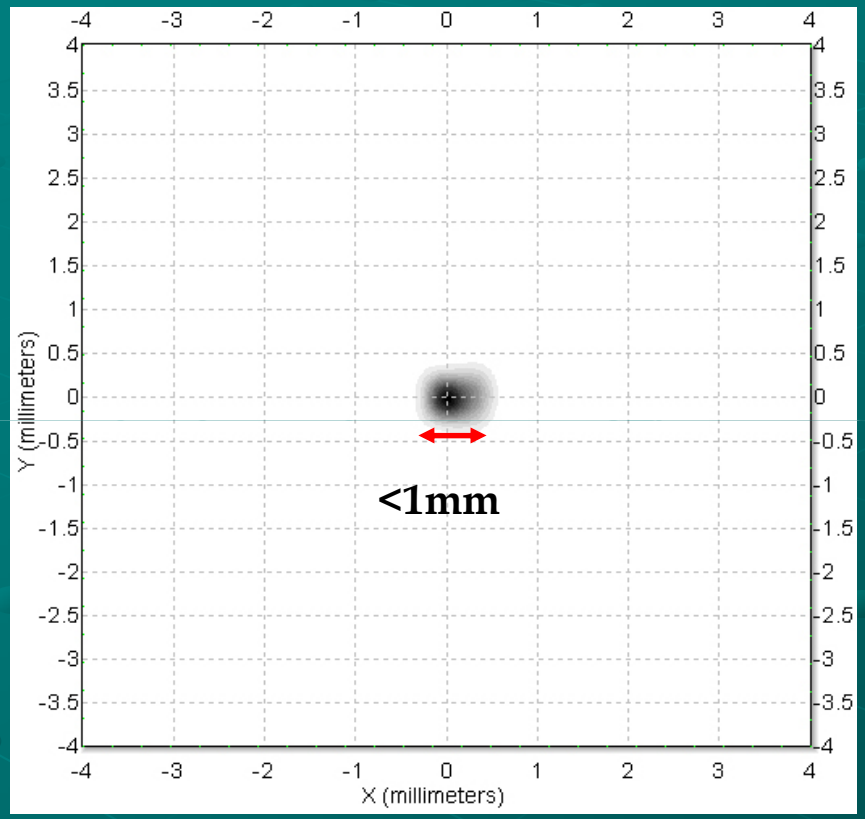


Total Internal Reflection Reflector (TIRR)

- Ray Tracing Simulation

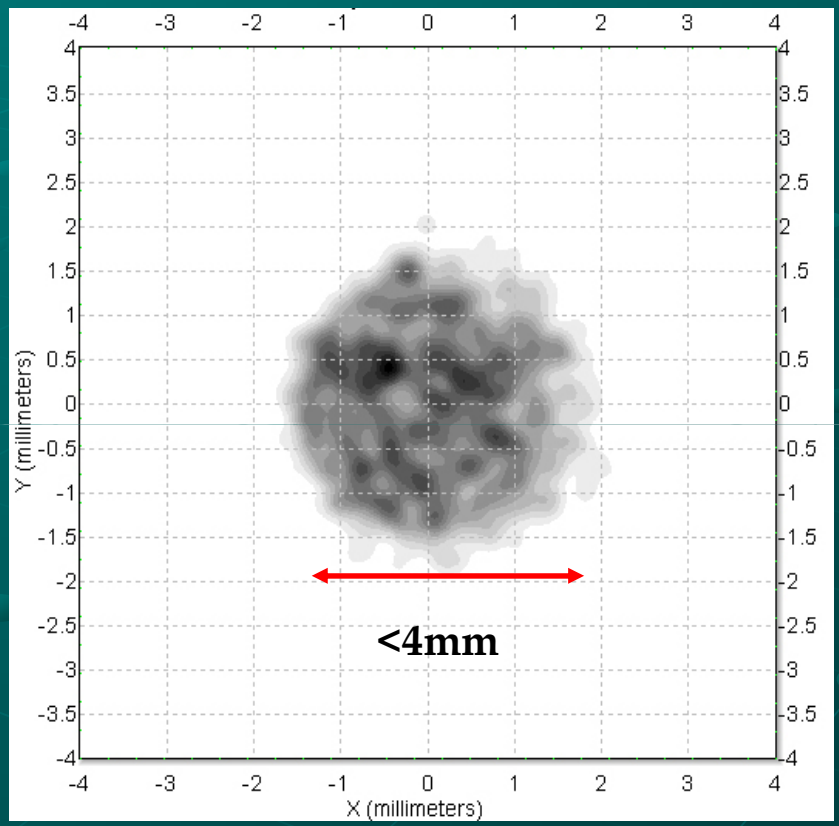


Ray Tracing Simulation Results



Geometrical Distribution

1:90.000

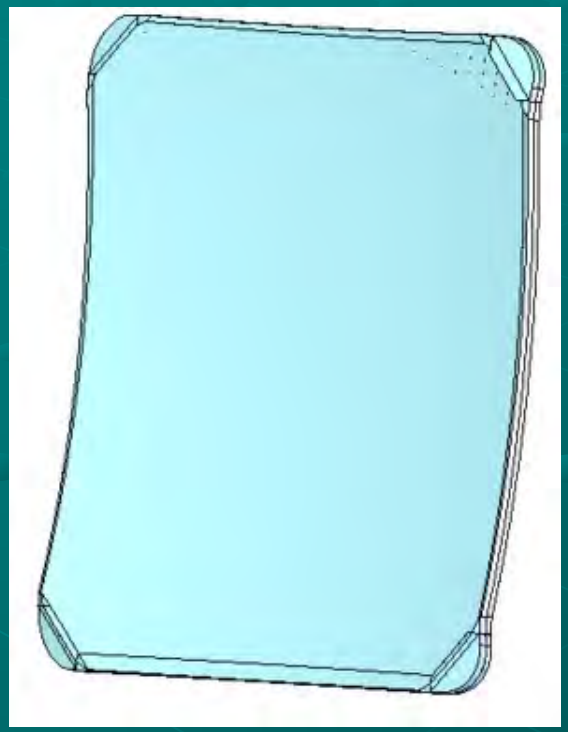


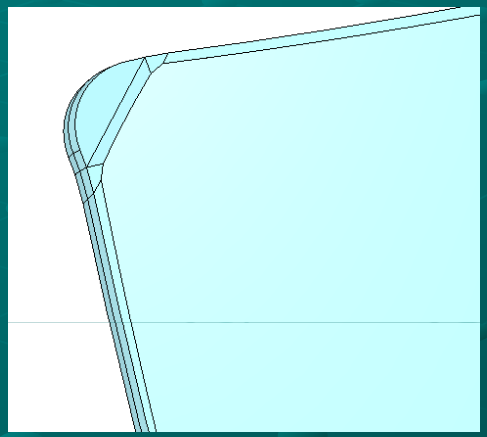
Solar Distribution

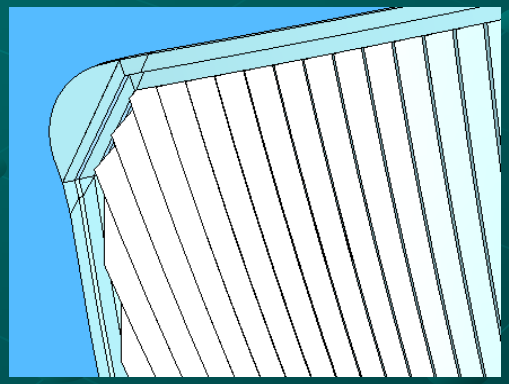
1:5.000

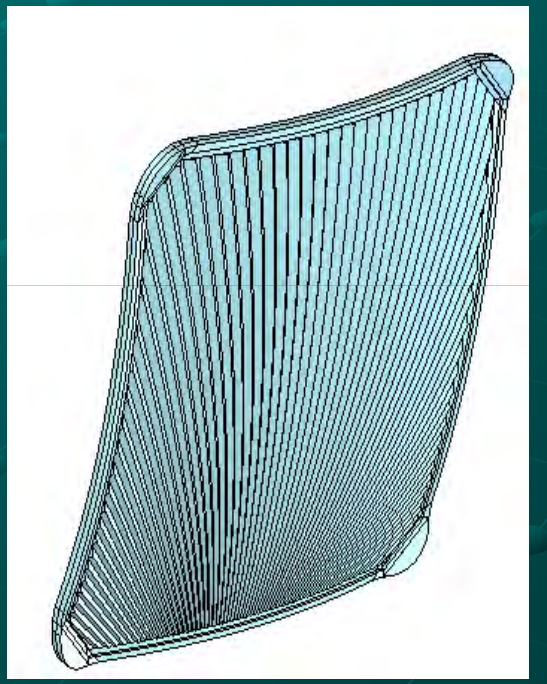
Final Design for the TIRR

- According to Glass Industry Restrictions









TIRR Glass Prototype in the Press

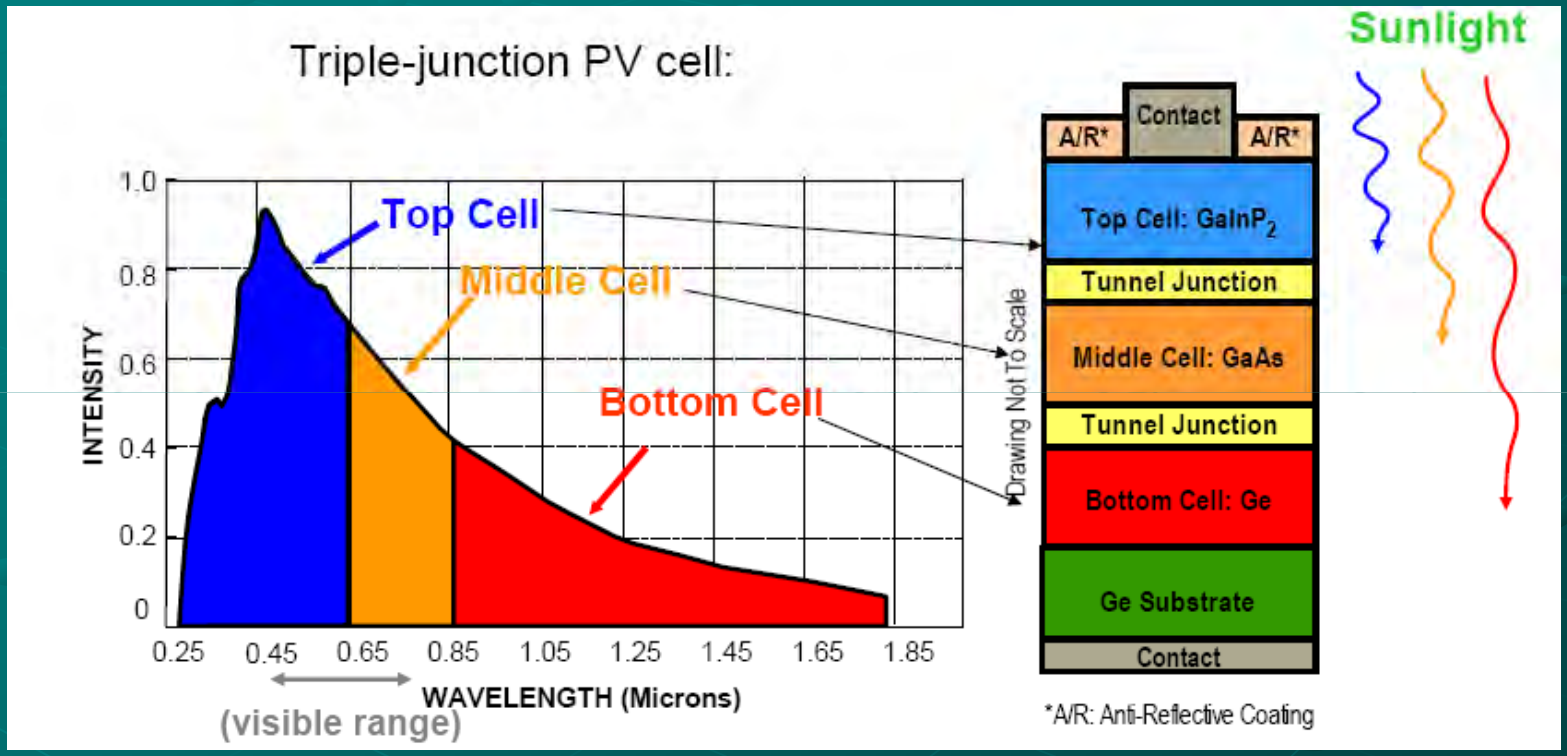
Concentrating Type PV 1:1000

60 x 120cm

100Wp

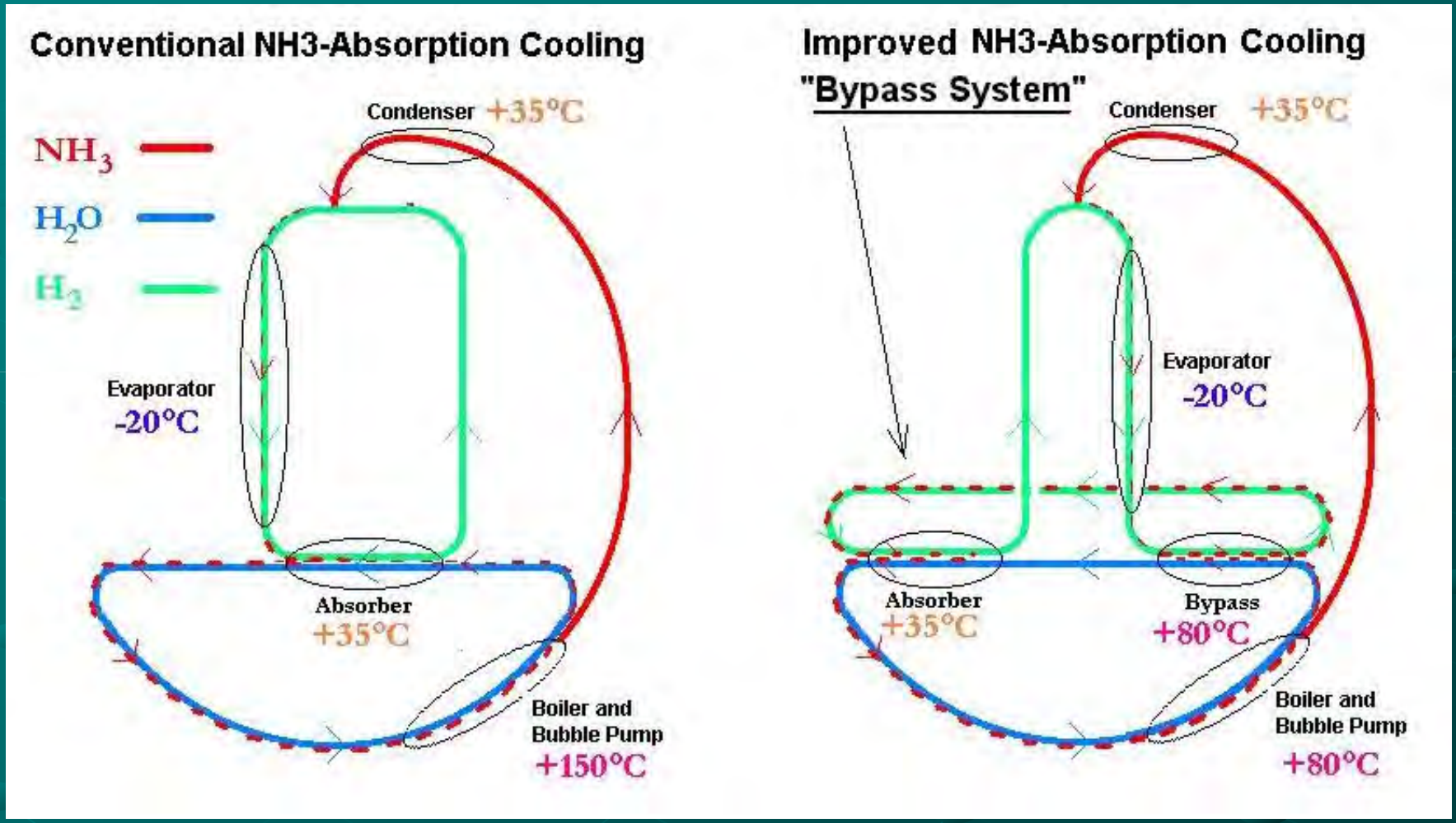
2,5 x 2,5cm

High Efficiency Multijuction Solar Cells of Spectrolab, n>40% , 20 years Warrantee



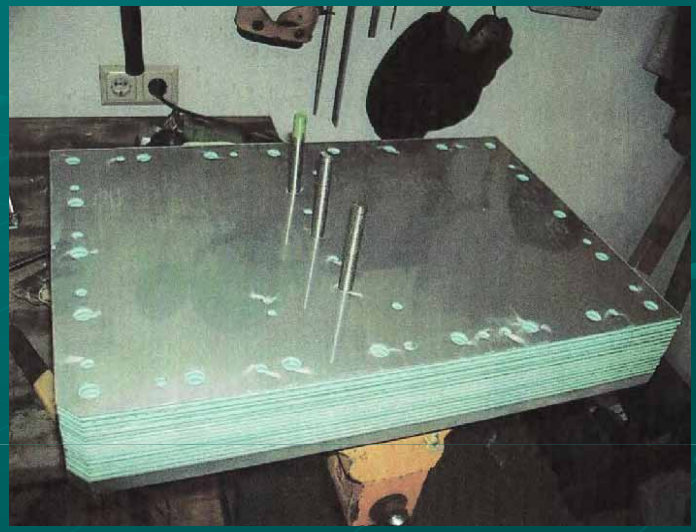
- Sandwich of materials divides the solar spectrum to maximize efficiency
- Power is a product of voltage and current
- Each junction adds voltage; current between junctions is matched in monolithic cells.
- Presents almost half the temperature coefficient of flat plate crystalline PV modules
- Suitable for efficient high temperature (80-95 degrees) operation and hot water yield

Absorption Cycle of Ammonia

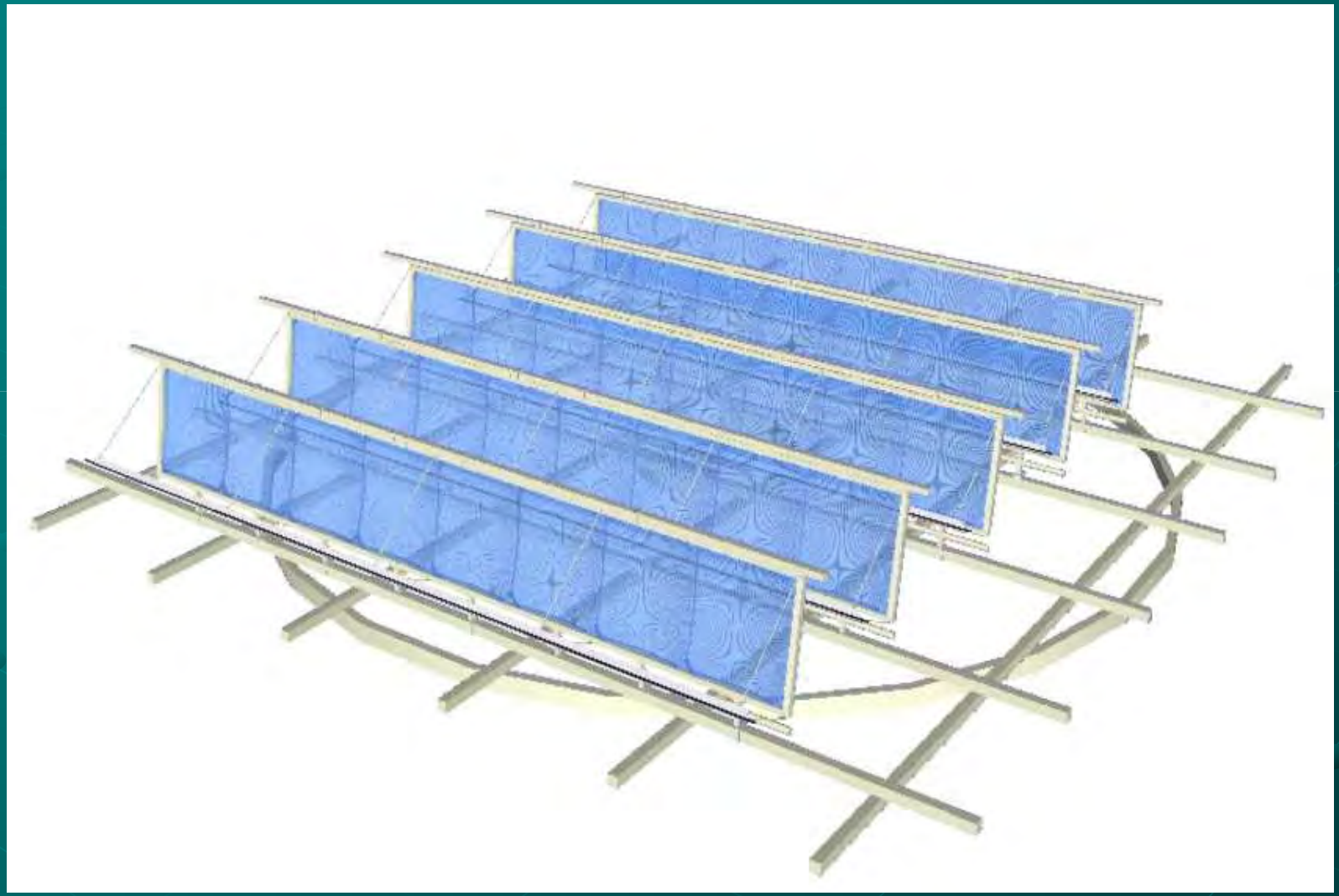


Absorption Heat Pump Compact

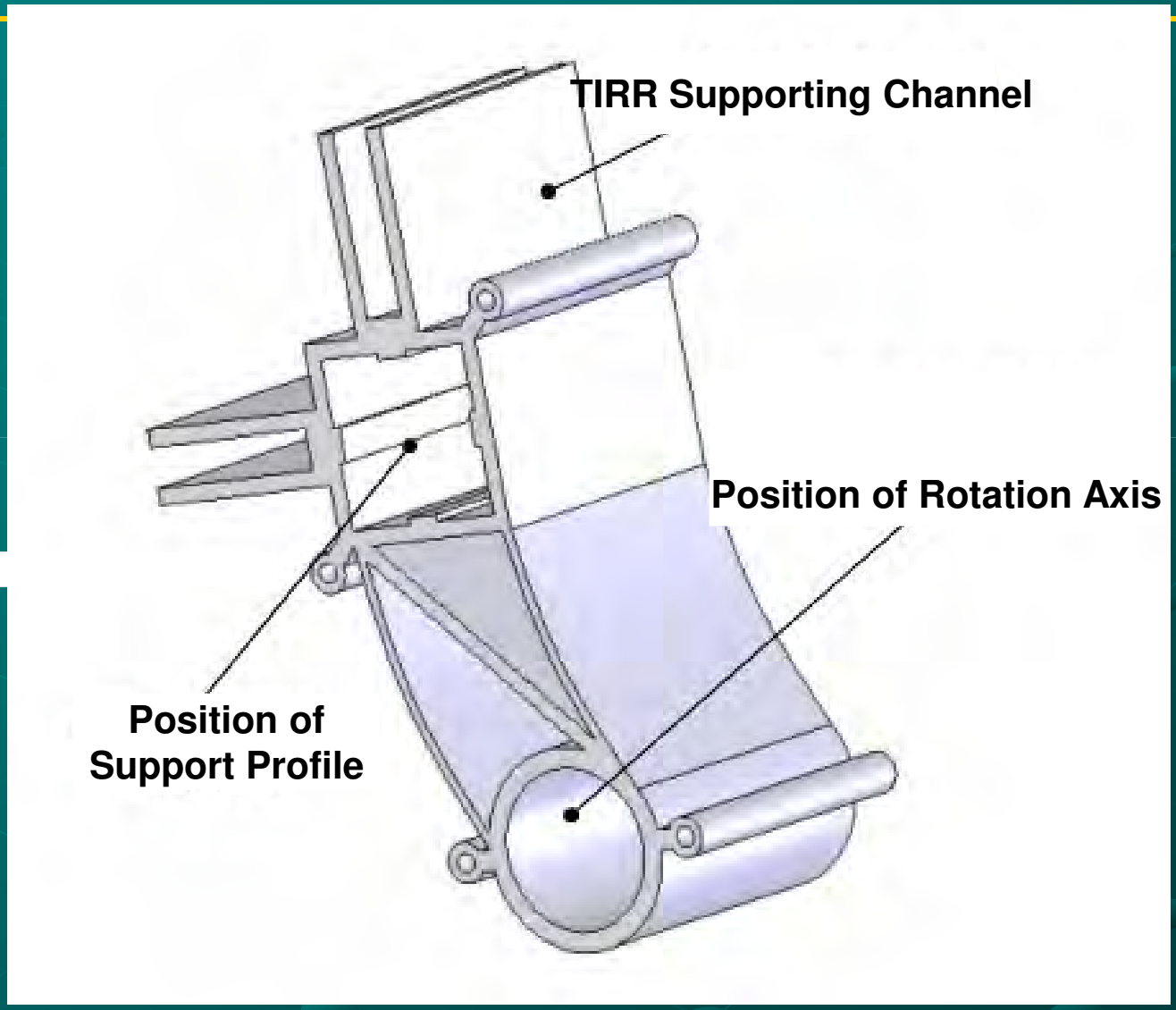
Absorption Heat Pump like a chip



TRIgeneration Basic Unit Side View

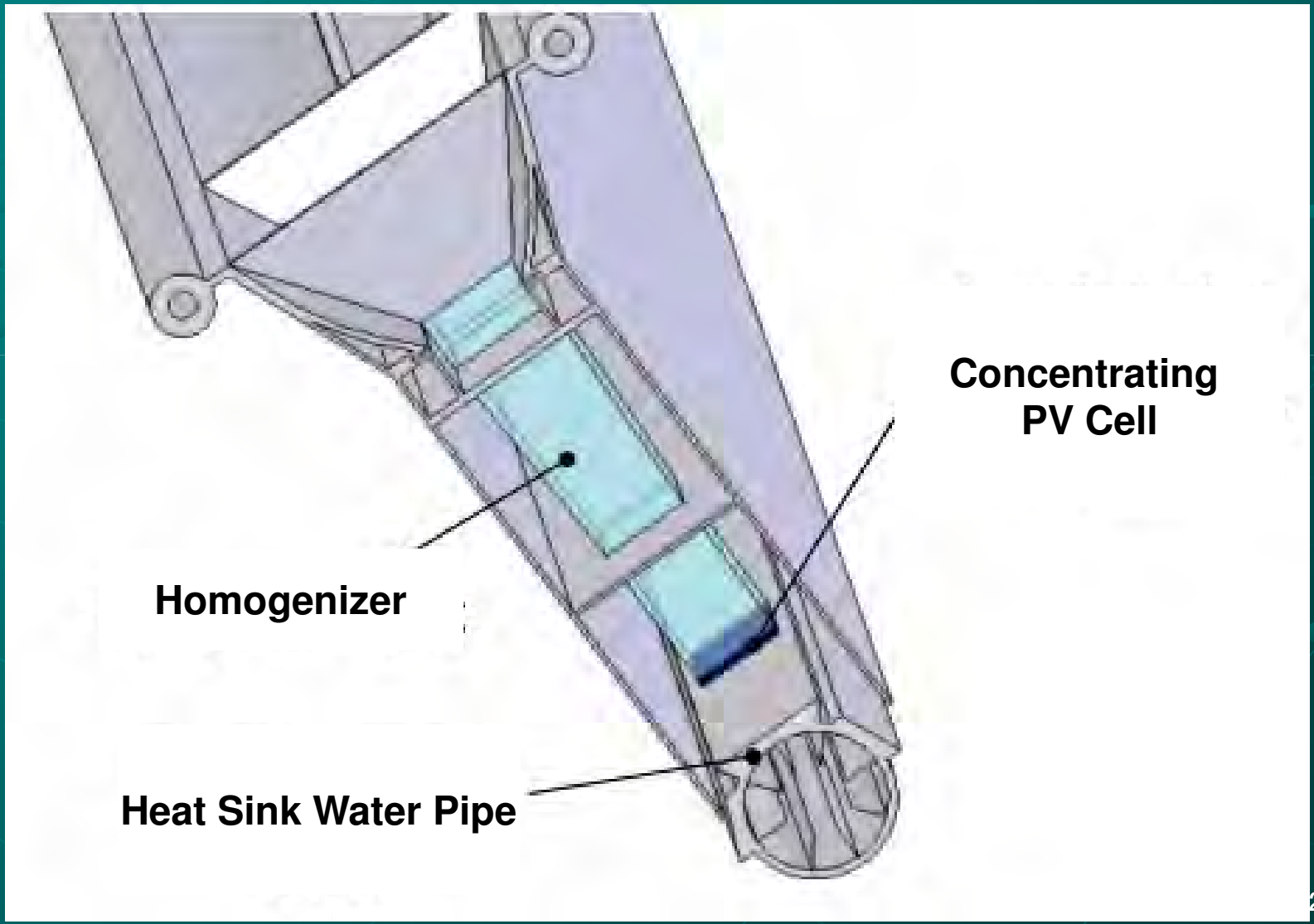


Detailed Engineering - Connection Profile (Design for production in a pilot line)



Reflector Package- Connection Profile

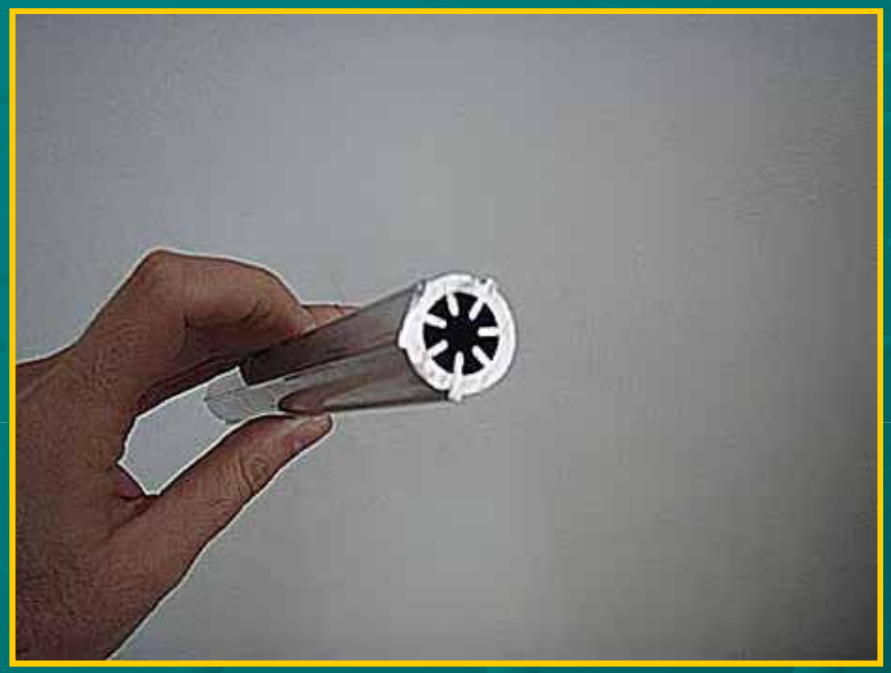
Secondary Optical System & Heat Sink Profiles (Design)



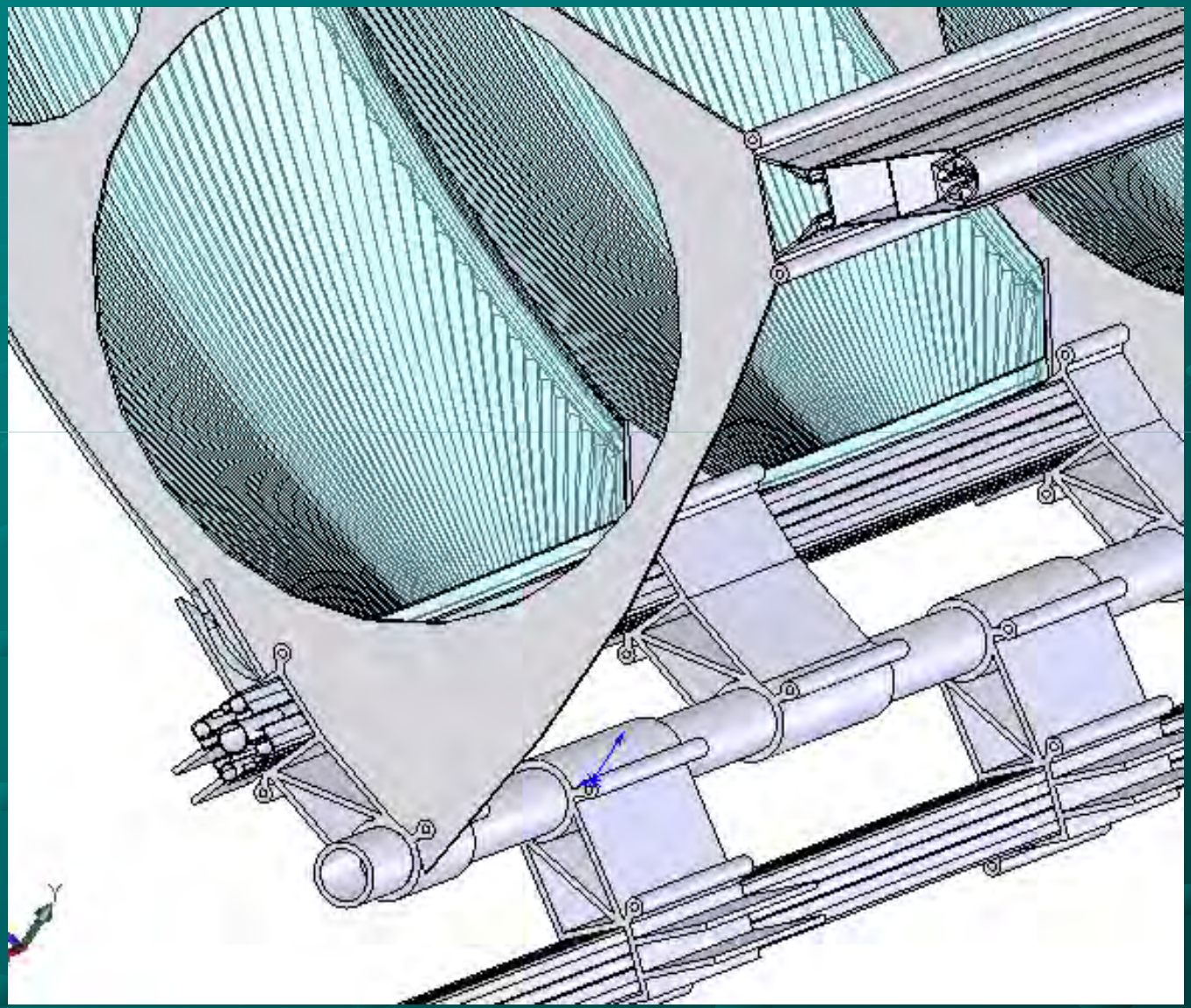
Secondary Optical System & Heat Sink Built

Details of Engineering- Reflectors Package

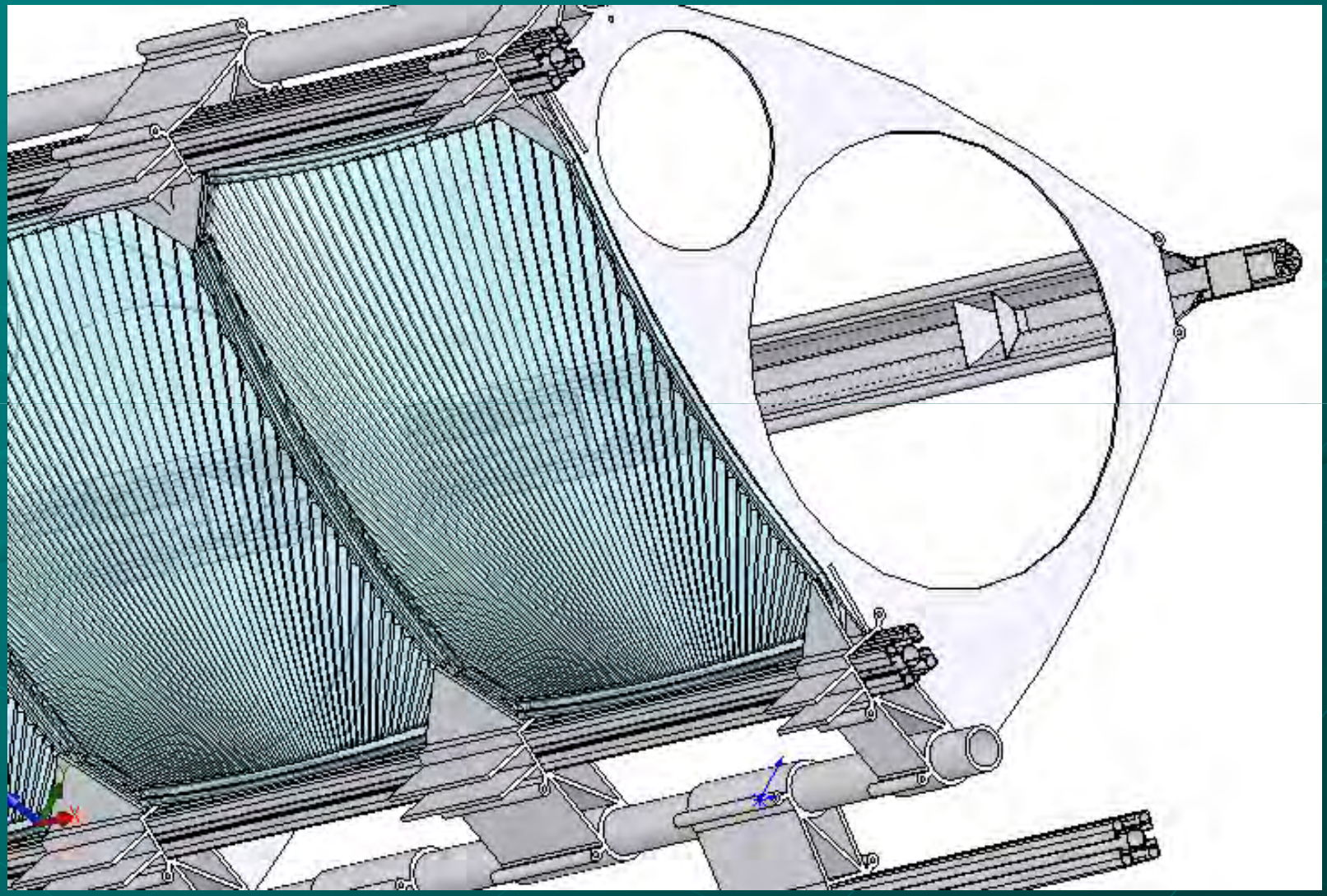
Photovoltaic Heat Sink (with detail of connection)



Concentrating Array (Front View)

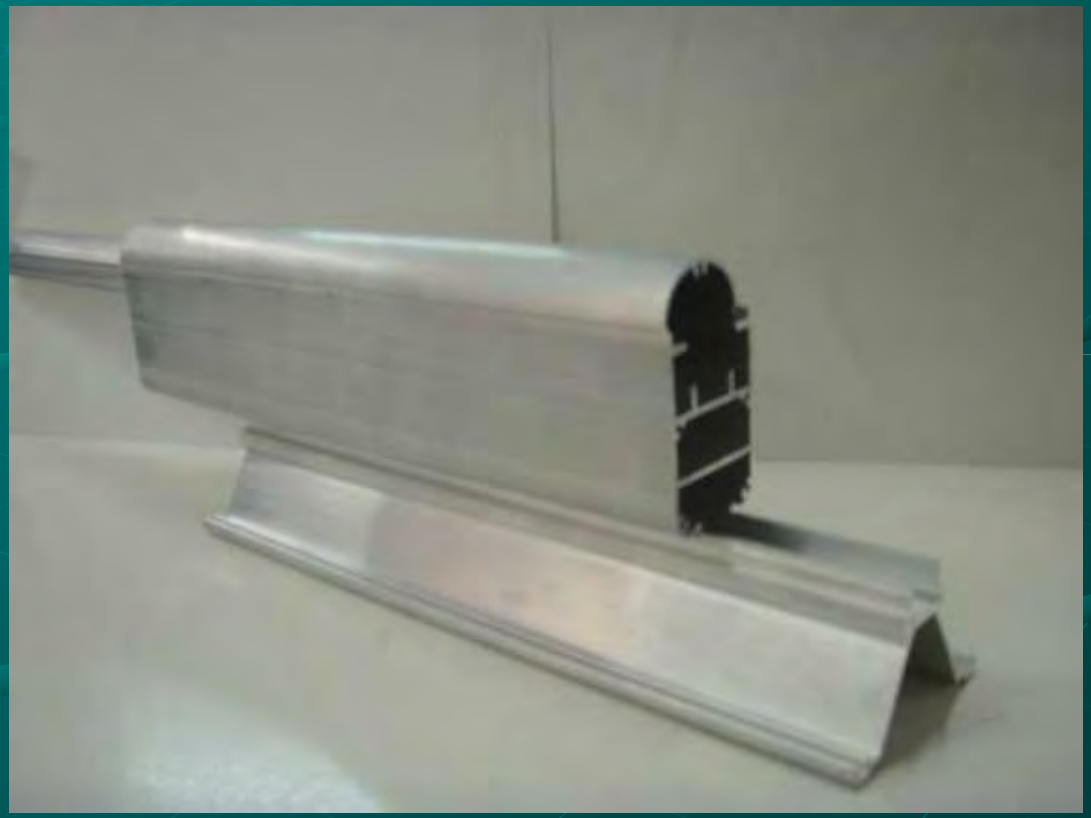


Concentrating Array - Secondary (Rear View)



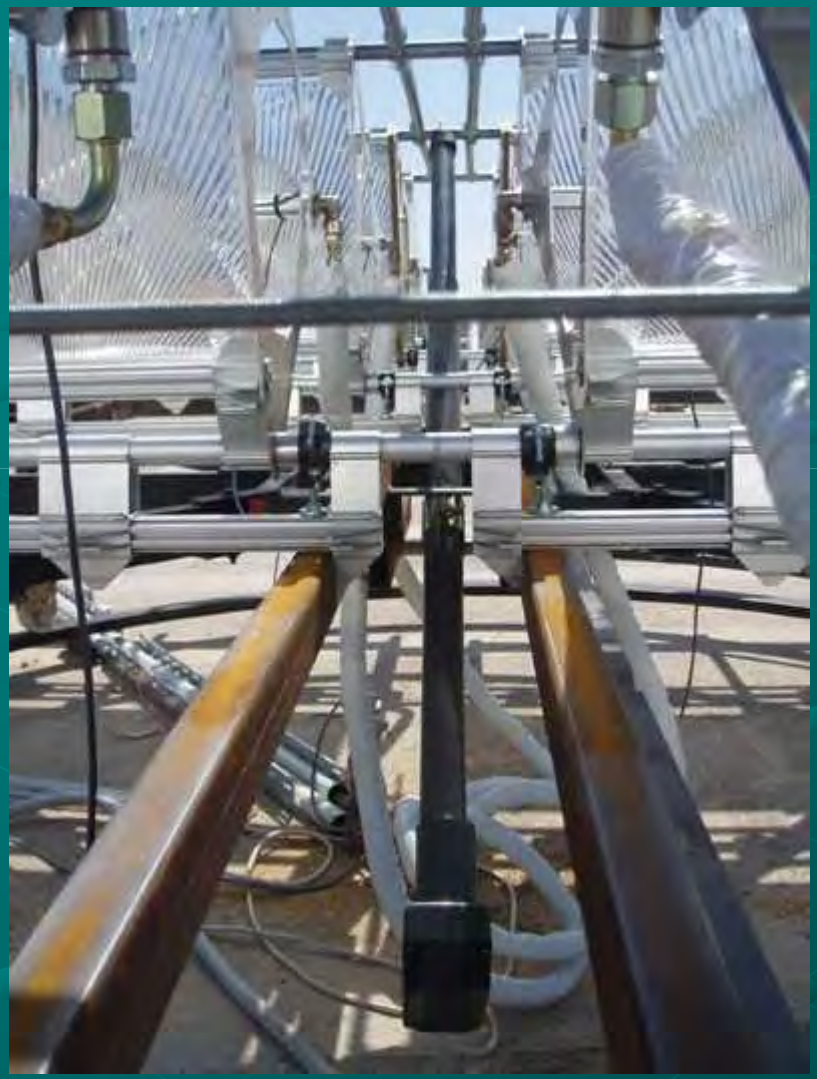
Concentrating Array (Front View)

Aluminum Profile Assembly (ready product)

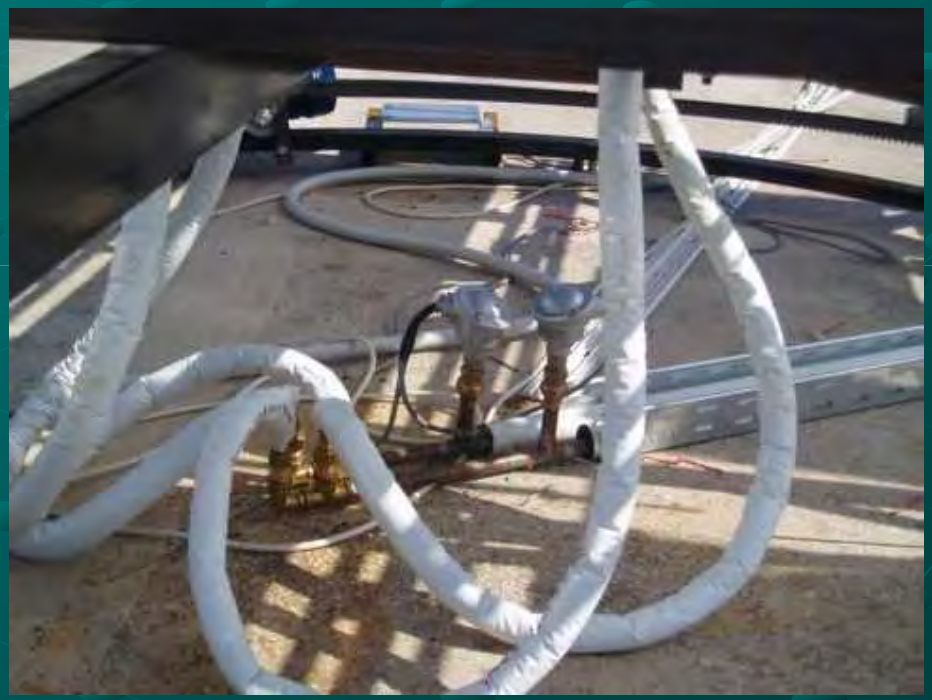


TIRR Molding for PMMA Production

Sun Tracking System Actuators/Tracker



Electrical Control and Hydraulic Pipes



The Solar TRIgeneration Unit ready

AKNOWLEDGEMENT THANKS OF SOLAR TRIGENERATION

- The Prototype presented above was constructed in the frame of the Programm ΠΕΠ-ATT-73 of the GSRT in cooperation with the PPC-KDEP and the National Technical University of Athens School of Chemical Engineering
- Many thanks to all cooperating parties for their contribution for the realization of the Programme and especially to GSRT and to the Ministry of Development for their support and contribution.

Thank You for your Attention