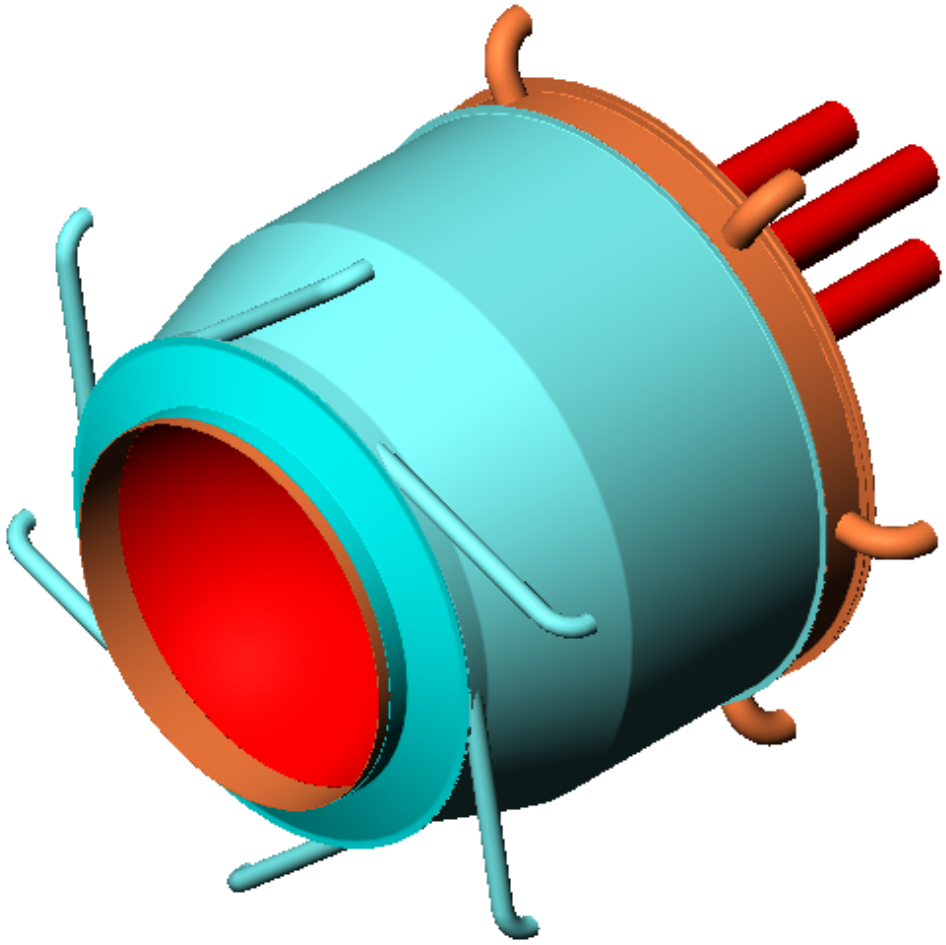
Dish-Stirling Hybrid Receiver Development

A Collaboration of:

SunLab
CFIC
Continental Heberle



Presented by:

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CONCENTRATING ♦ SOLAR ♦ POWER

Sun♦Lab

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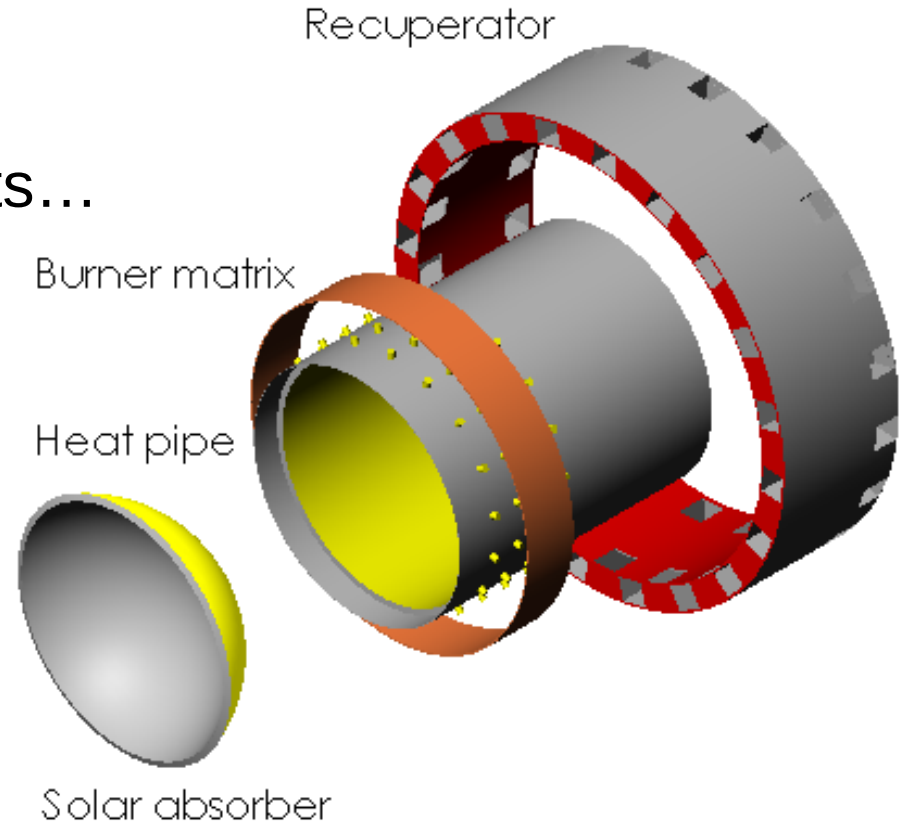
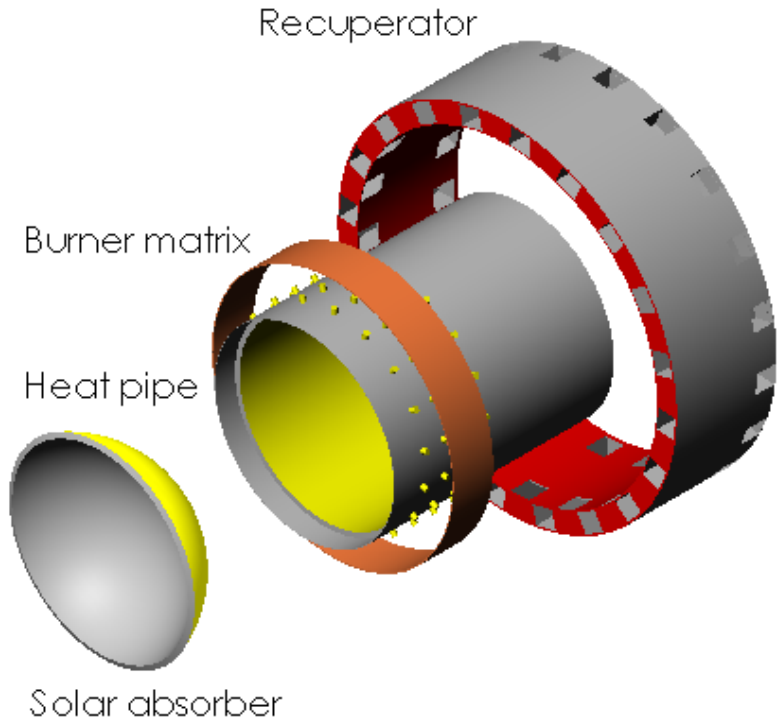
Project Background

- **Hybrid Receiver Concept**
  - Fuel-augmented solar
  - Not either/or
  - Four major components…



Project Background

- **Motivation: industry-identified need**
  - Utilities:
    - capacity payments
  - Remote applications:
    - nights/cloudy days
    - single power converter



Project Definition

- **Objective: develop a 75-kW$_t$ throughput hybrid receiver for dish-Stirling applications**

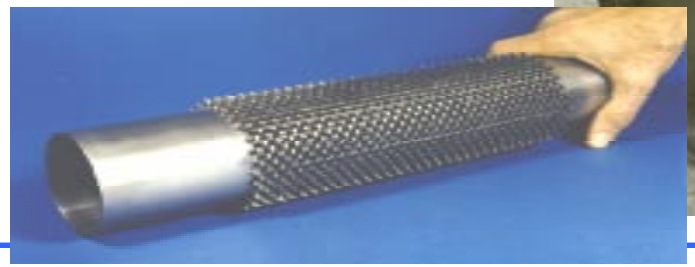
FY	FTEs	DCs($k)	Activities
96 (8/96 start)	1.0	20	1/6-scale design, build, & test.
97	1.5	100	
98	2.0	100	1/6-scale mod & test. Full-scale design.
99	2.0	200	
00	2.9	167	Full-scale design, build, & test.
01 (10/01 end)	2.3	172	

Hybrid Receiver Development Goals

- **Desired receiver characteristics:**
  - Fuel-augmented solar (not either/or)
  - 75 kW_t throughput at 750 C
  - 75% thermal efficiency at design point
  - Low emissions
  - Cost competitive with diesel augmentation

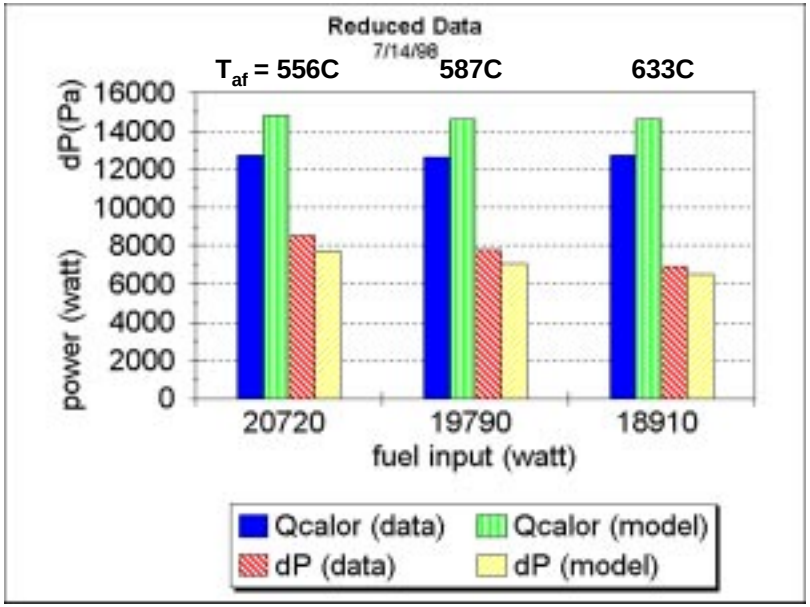
Hybrid Receiver Development Approach

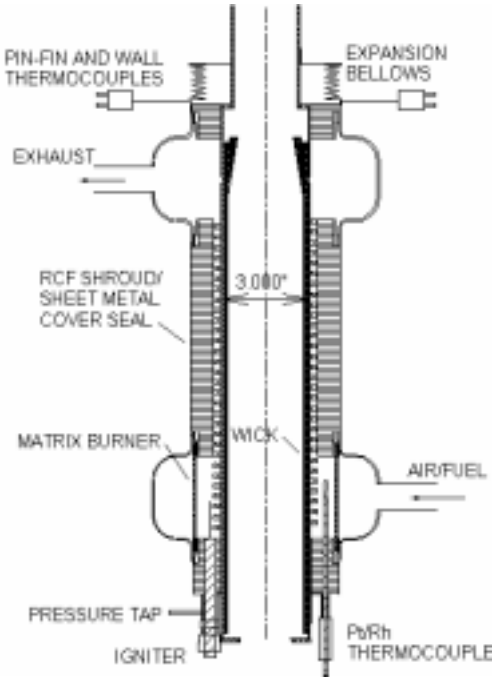
- **Clean-sheet design**
  - Extensive CFD and FEA modeling (heat transfer, pre-ignition, stress)
  - Manufacturers involved to assure manufacturability and low cost
  - Tightly integrated for efficiency
  - Stud-welded pin fins: least expensive extended area
  - Metal matrix burner selected for low emissions and compactness
- **Development process**
  - MS Project planned & tracked
  - Natural gas initially; option for other fuels
  - 1/6-scale device first, for proof of concept



Hybrid Receiver Development Progress

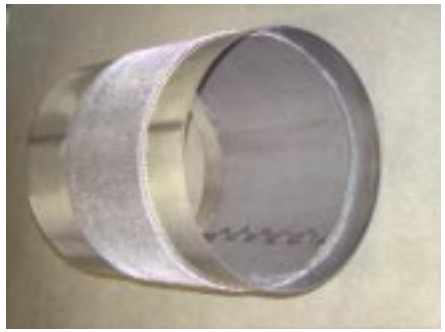
- **1/6-scale accomplishments**
  - Nox~18 ppm
  - CO~40 ppm
  - System model validated…

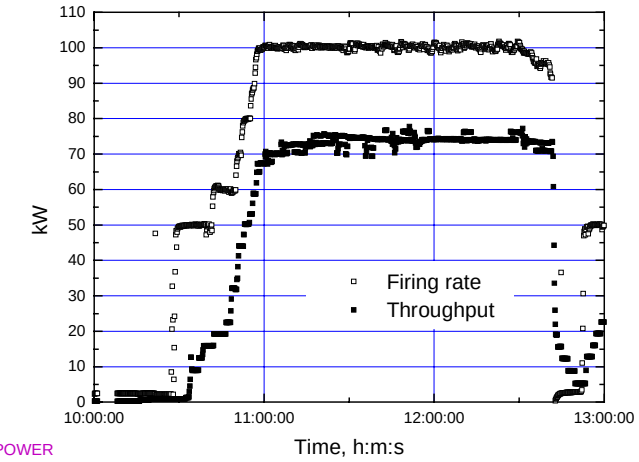




Hybrid Receiver Development Progress

- **Full-scale receiver accomplishments**
  - Tested at:
    - 25 to 100+ kW_t firing rate
    - 12 to 80º elevation
    - Up to 750C heat pipe temperature, 640C preheat
  - Starts smoothly, stable, no pre-ignition or detonation





Hybrid Receiver Development Progress

- **Other accomplishment details**
  - Developed manifold giving < 1% fuel/air variation
  - Developed high speed stud welding process
    - Rapid 100% ultrasound inspection
    - Acceptable weld quality and distortion
  - Designed successfully to prevent thermal wracking
  - Manufacturer's cost estimates (vs $7500 diesel)
    - Combustor/recuperator: $4150 @ 10^4/y
    - Pin-finned cylinder: $ 1170 @ 10^4/y
  - 3 papers, 1 patent application

Hybrid Receiver Status/Issues

- **Testing**
  - Check instrumentation to close energy balance
  - Emissions
  - Combined solar/gas
- **Hardware**
  - Wick hot spot has appeared – may be fixable
  - Address indication of occasional leakage at critical seal
  - Evaluate lifetime potential
  - Alternate fuels