A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Trough Receiver Heat Loss Testing

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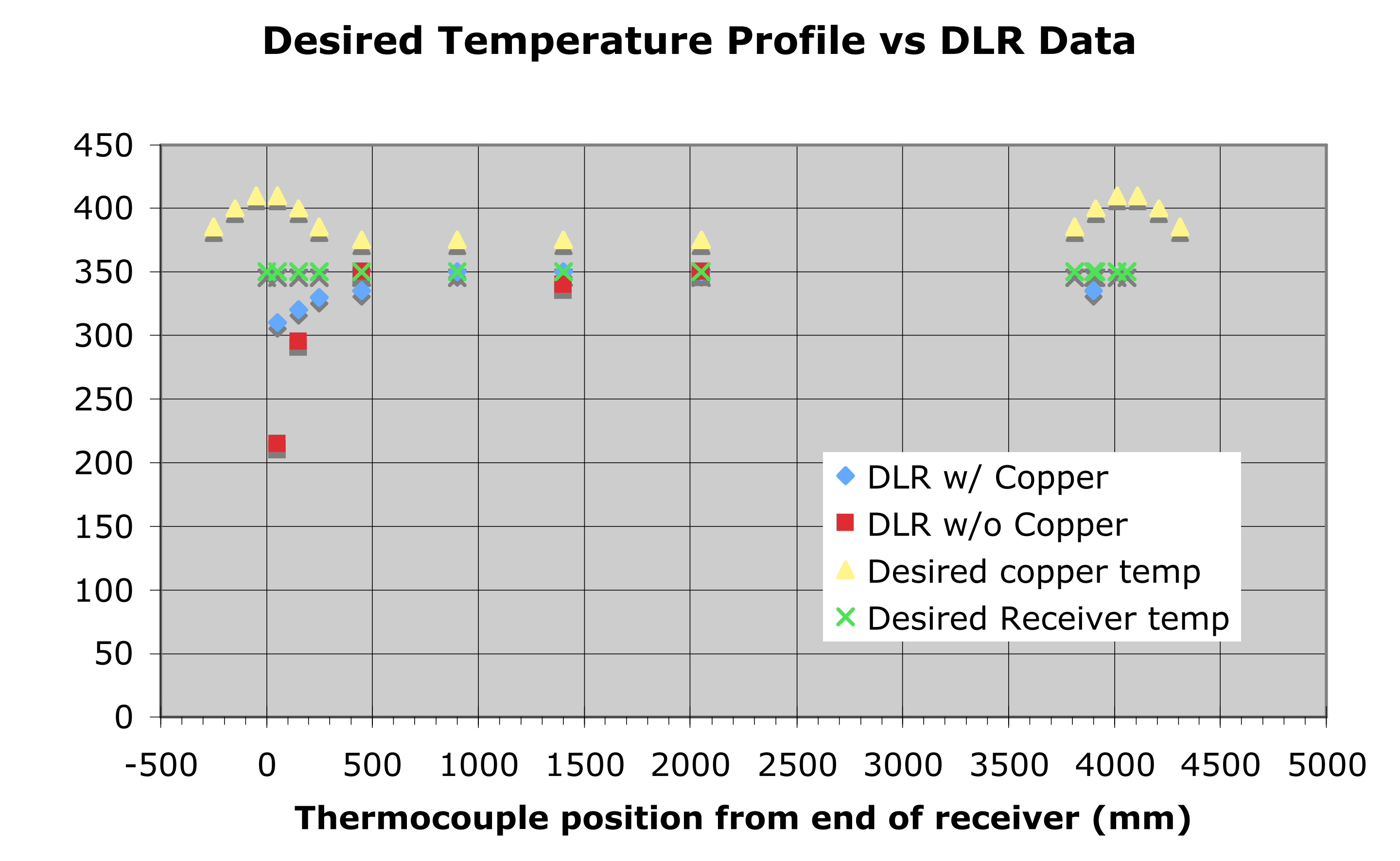
Project Description

- Design, fabricate, assemble, commission and qualify an experimental capability for thermal loss testing of full-size trough receiver elements
- Conduct detailed thermal loss testing on a variety of receivers
- Assess the impact on thermal loss of selected gases within the annulus of a modified Schott receiver

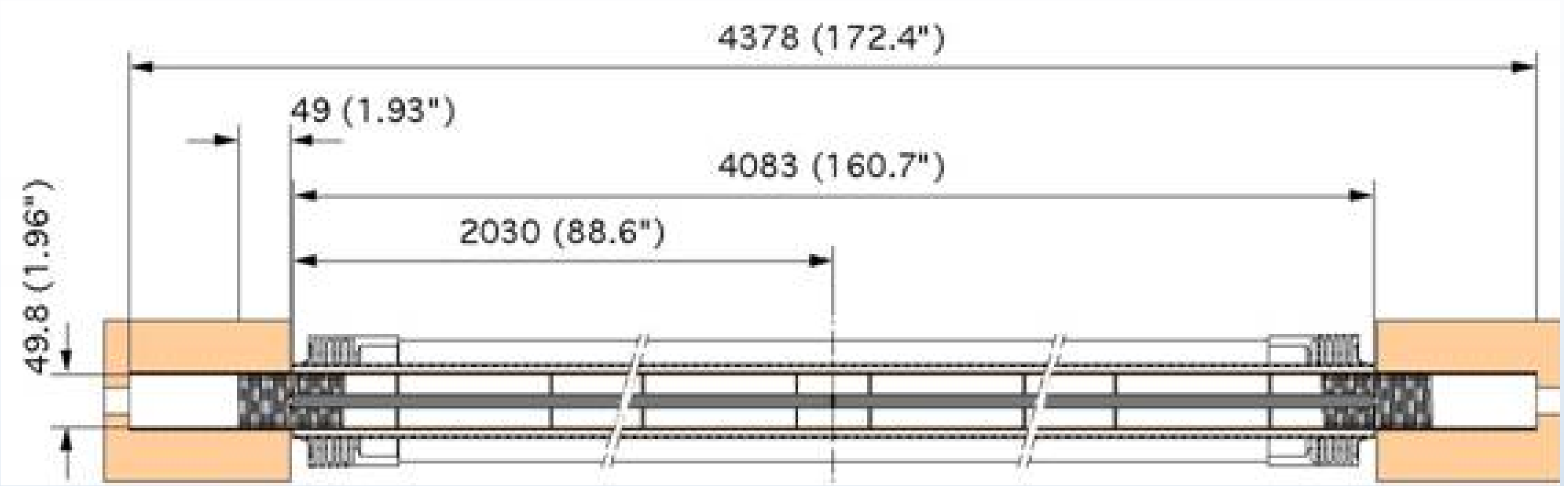
Project Goals

- Improve on the experimental apparatus at DLR, particularly with respect to end loss
- Compare experimental with analytical results to improve trough performance models
- Use results to better understand field performance issues related to receivers

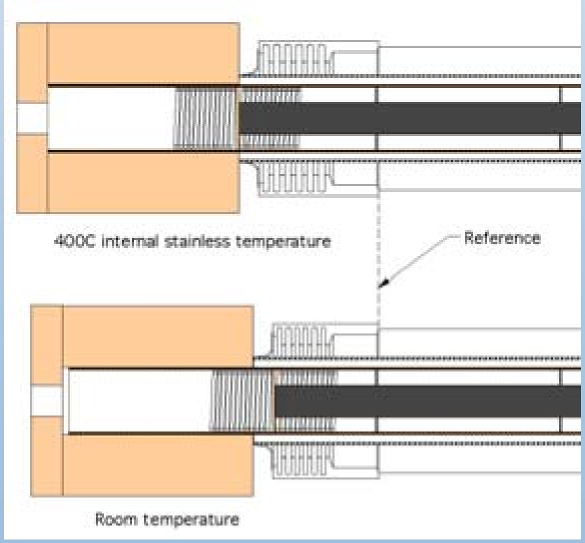
DLR Design Issue



Design Concept



- Shown with relative expansion at 400°C



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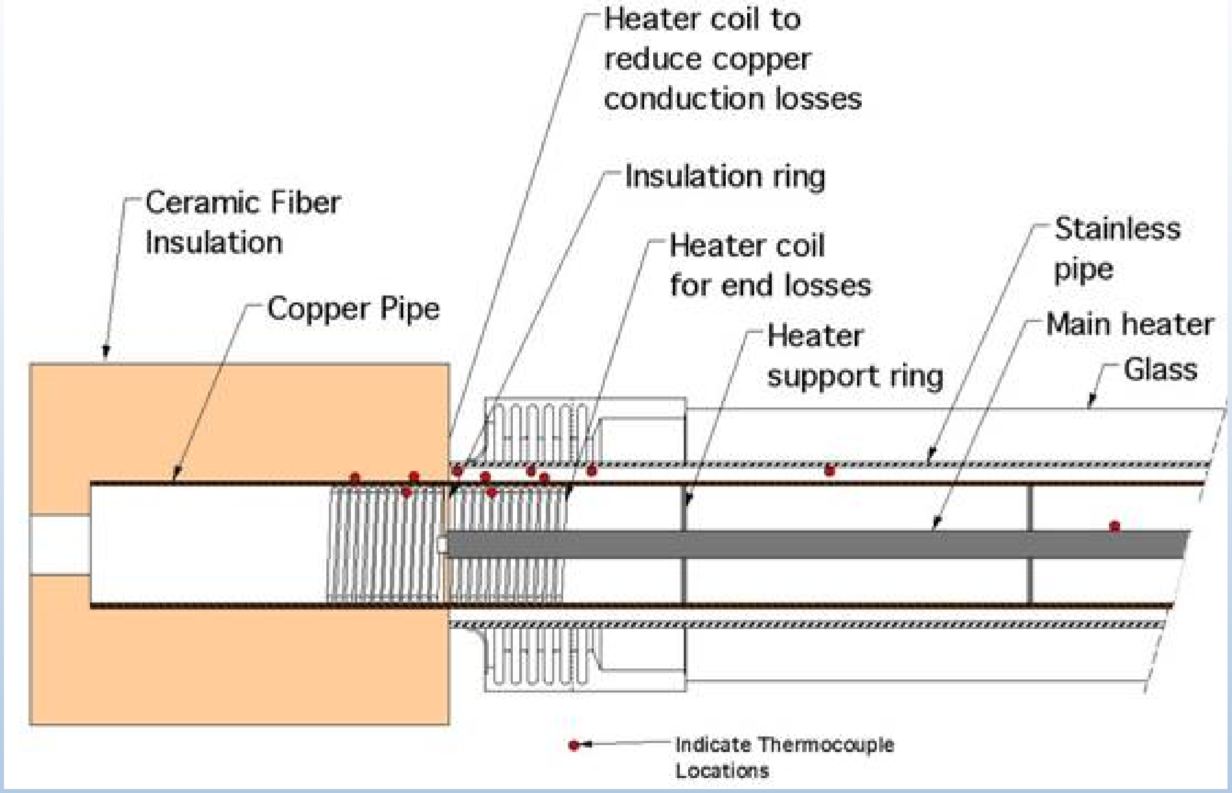

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Receiver Elements

- Currently in-house
  - New Schott (with port to annulus fitted to glass envelope)

- From FPL
  - New Schott
  - New Solel UVAC
  - Good black chrome (SEGS VI)
  - Cool & Hot Luz Cermet (SEGS VI generation)
  - Cool & Hot Luz Cermet (SEGS IX generation)
  - Fluorescent & Lost Vacuum Luz Cermet (SEGS IX generation)
  - Washed Fluorescent Receiver (SEGS IX generation)
  - Cold side and Hot side UVAC receiver (SEGS VI test loop original batch)
  - First year Solel Cermet receiver
  - Refurbished tube w Pyromark paint (SEGS VIII)

Current Status

- FPL shipped 10 receivers
  - 1 bare, 1 fluoresced, 8 from various field locations
- Experimental hardware assembled and installed in FTLB 118
  - DACS based on OPTO22
  - Custom heaters and controls from Watlow
  - Safe Work Permit issued last week; checkout testing began
  - Controls tuned using bare tube receiver
    - Temperatures up to 500^{o}C
- Additional features
  - IR camera for envelop temperatures
  - Several room temperature measurements to assess stability over time
- Bob Meglan and Ed Wolfrum have developed a gas monitoring system and tested in the field
  - Will be used in lab in conjunction with receiver tests

FTLB 118

FTLB 118

FTLB 118

Development of a Prototype Device for the non-Invasive *in situ* Measurement of Hydrogen in Heat Collection Elements (HCE)

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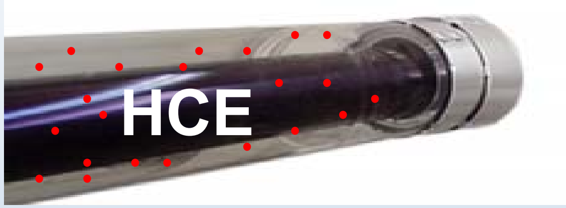
Problem

Oxidation of the heat transfer fluid produces **hydrogen gas** which eventually permeates through the steel tube.
This reduces the vacuum and increases heat loss to the outer tube.



When the pressure reaches 0.1 torr (13 Pa) the heat conduction losses are unacceptable.

Importance/Drivers

- HCE failure/degradation is the single largest cost factor for current plants.
- 30-40% failure at SEGS VI-X (9 to 11 yrs operation)
- Loss of vacuum (glass-to-metal seal or **hydrogen permeation**), solar selective coating in air, broken glass.
- Replacement cost is ~$1000 / HCE
- Annual operation and maintenance cost is 0.5¢/kWh

http://www.eere.energy.gov/troughnet/pdfs/mahoney_receiver_devel.pdf

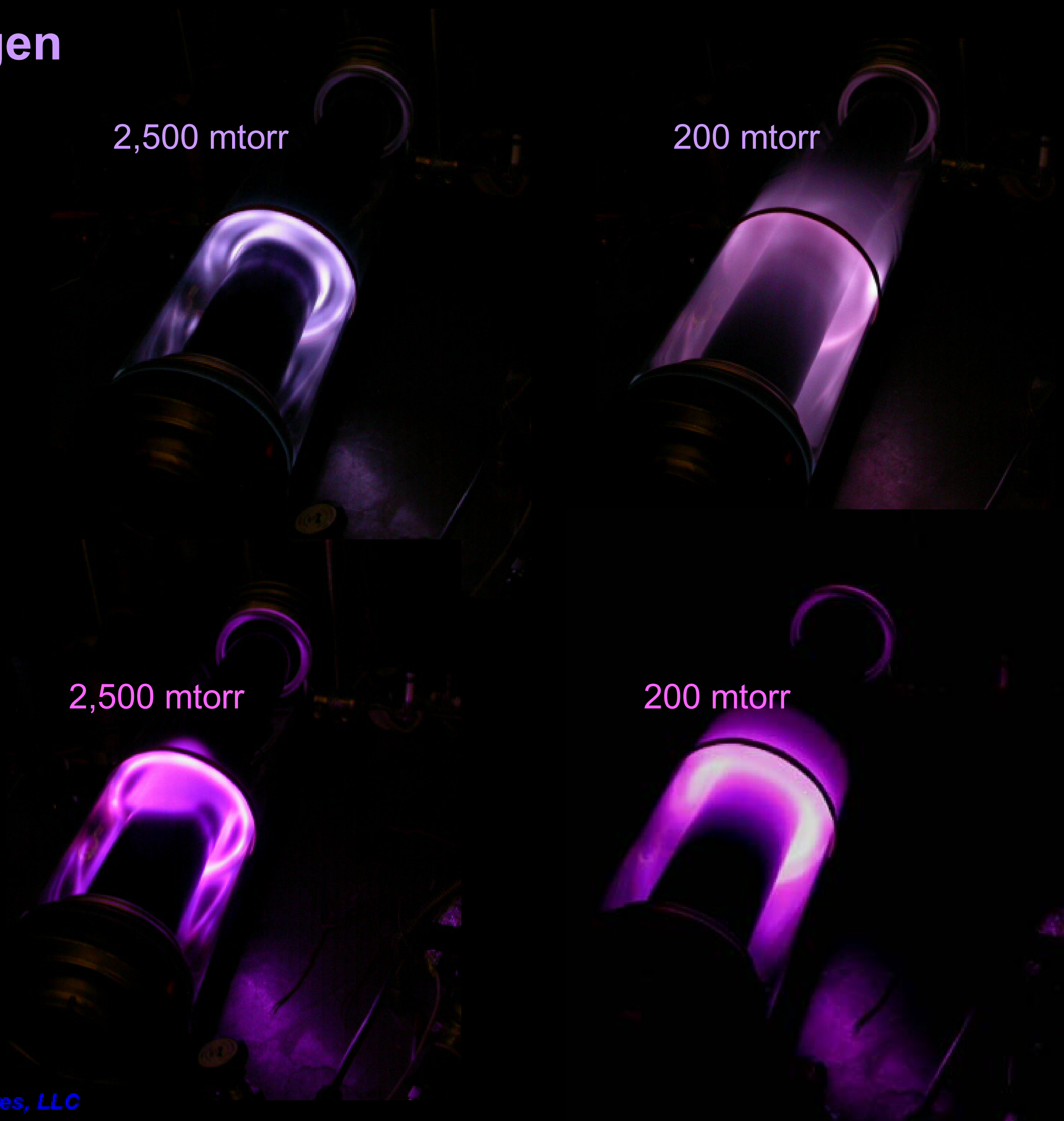
Results/Conclusions

- We have constructed a device for noninvasive identification and quantitative measurement of gases.
- We have successfully calibrated the device and proved the concept in the laboratory
- We have successfully demonstrated the device in the field.
- Hydrogen was measured in several HCE’s in the field.
- The basic components work in the field and could be ruggedized and optimized.

Plasma Emission Demonstration in HCE

Hydrogen

Air



Latent Structures, LLC

NREL

Emission Spectra Gathered in the Laboratory and in the Field

HCE in the Lab

HCE in the Field