HARPS-NEF
Thermal System Design and Analysis

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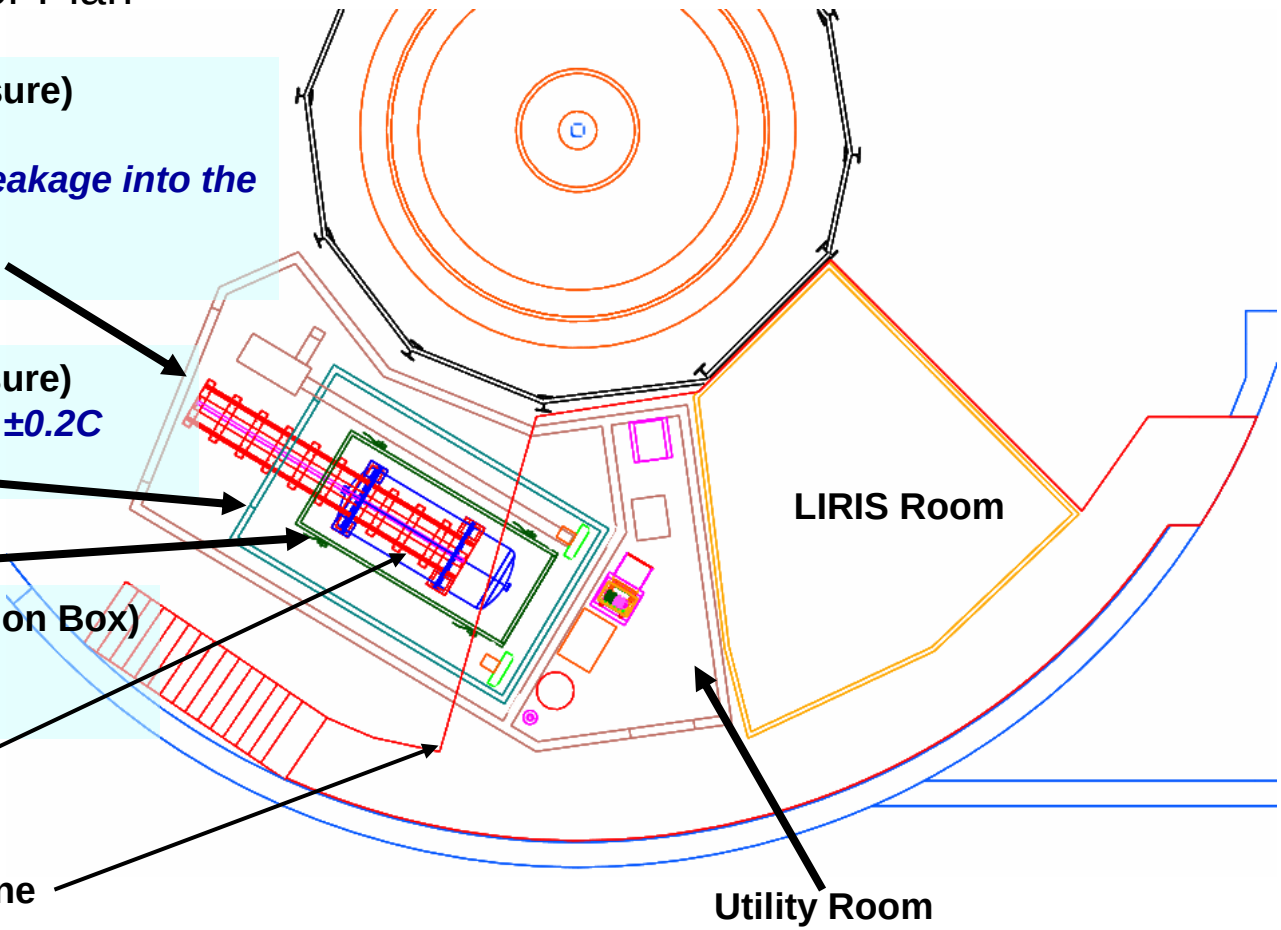
HARPS-NEF: List of Requirements, Thermal

HARPS-NEF Floor Plan

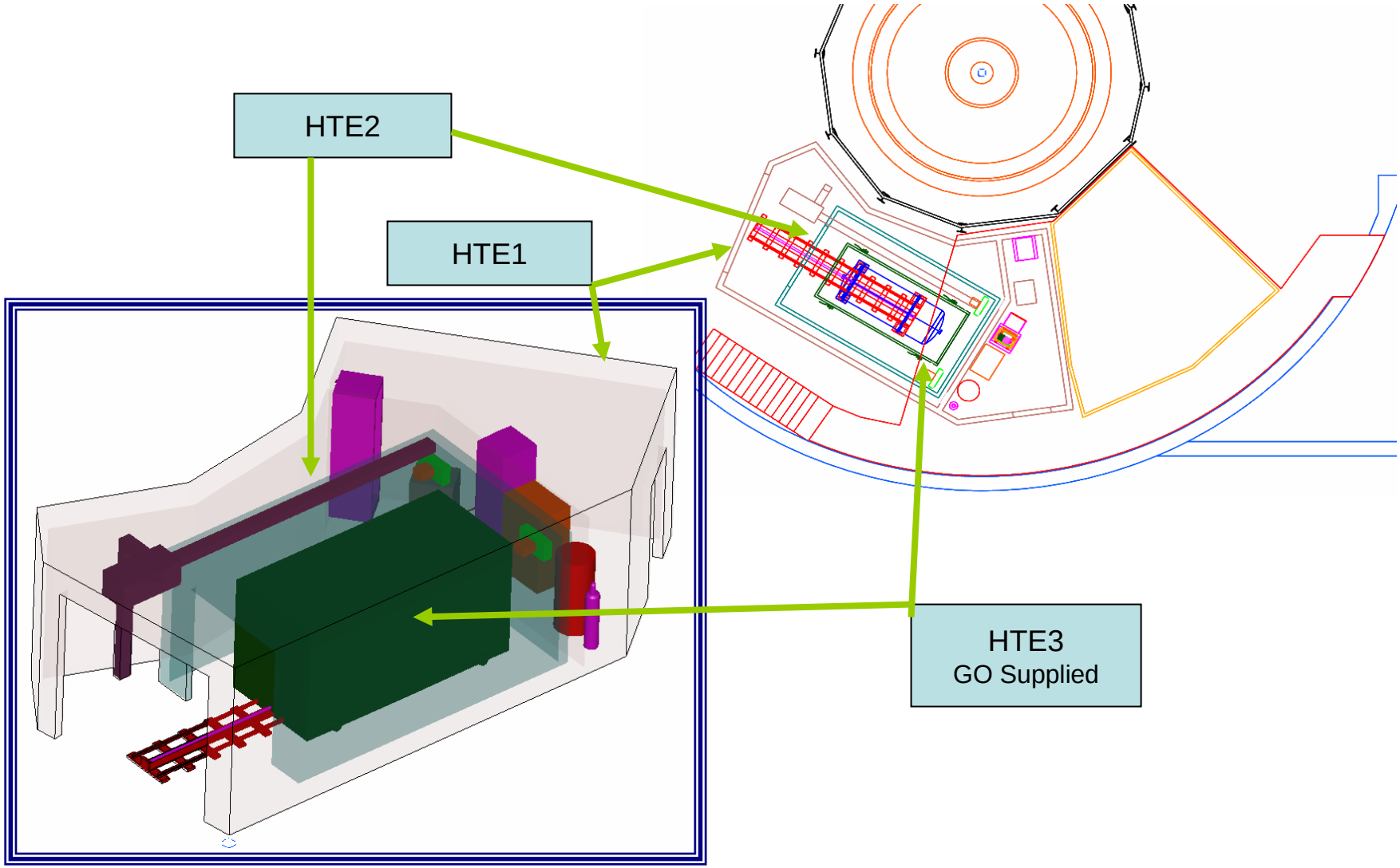
HTE 1 (Outer Most Enclosure)
•Primary Requirement:
Less than 100w thermal leakage into the dome year around.
•+18 ±1.5C

HTE2 (Intermediate Enclosure)
Primary Requirement: +15 ±0.2C

HTE 3 (Spectrograph Isolation Box)
GO Supplied: +17 ±0.01C



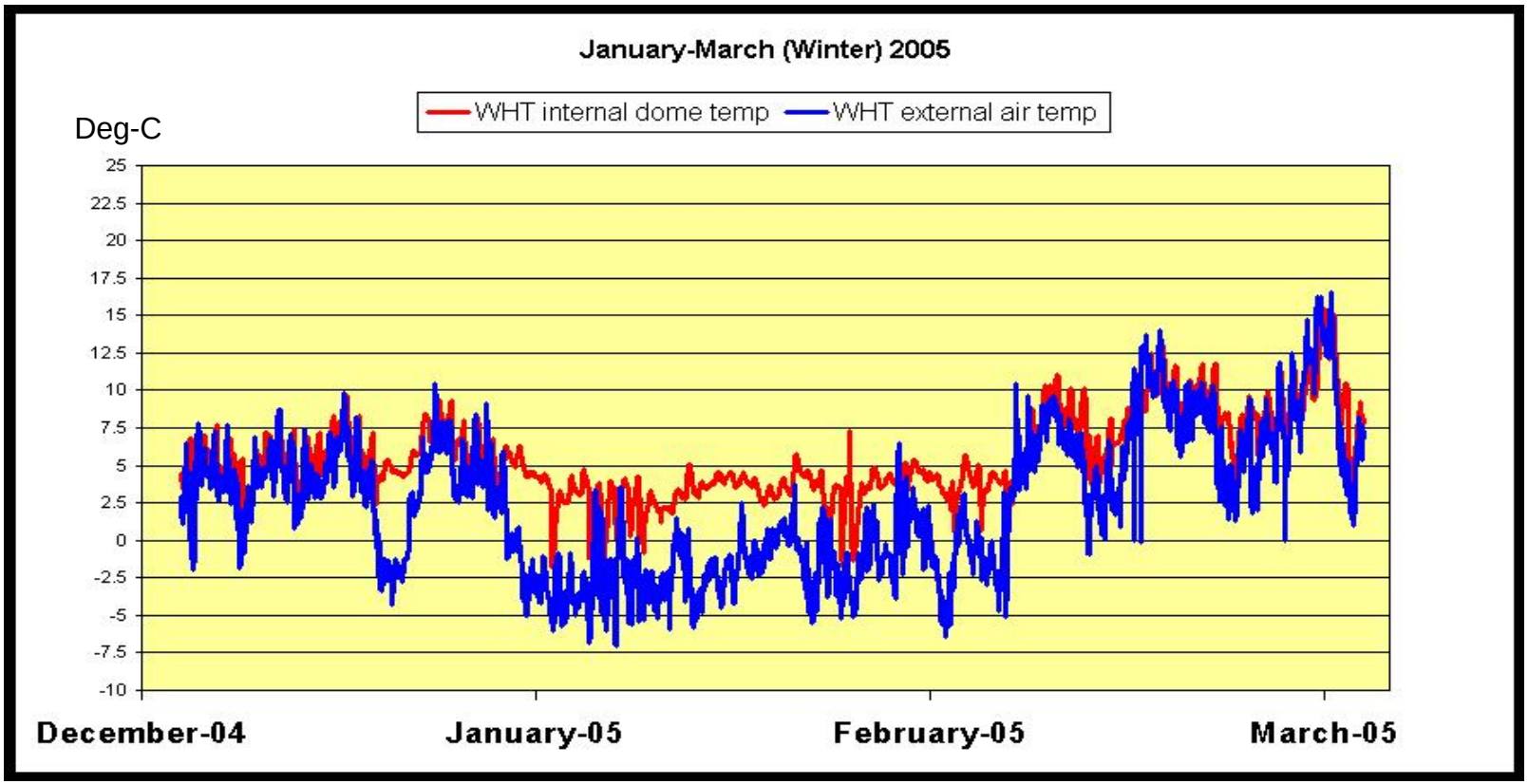
HARPS-NEF: Thermal Enclosure System Design



HARPS-NEF: Environmental Conditions

- Altitude: 2400m (~8k feet)
- Temperature Profiles (+4 to +25C WHT Internal Temp, per observed 2005)

Winter Season



HARPS-NEF: Environmental Conditions

- Altitude: 2400m (~8k feet)
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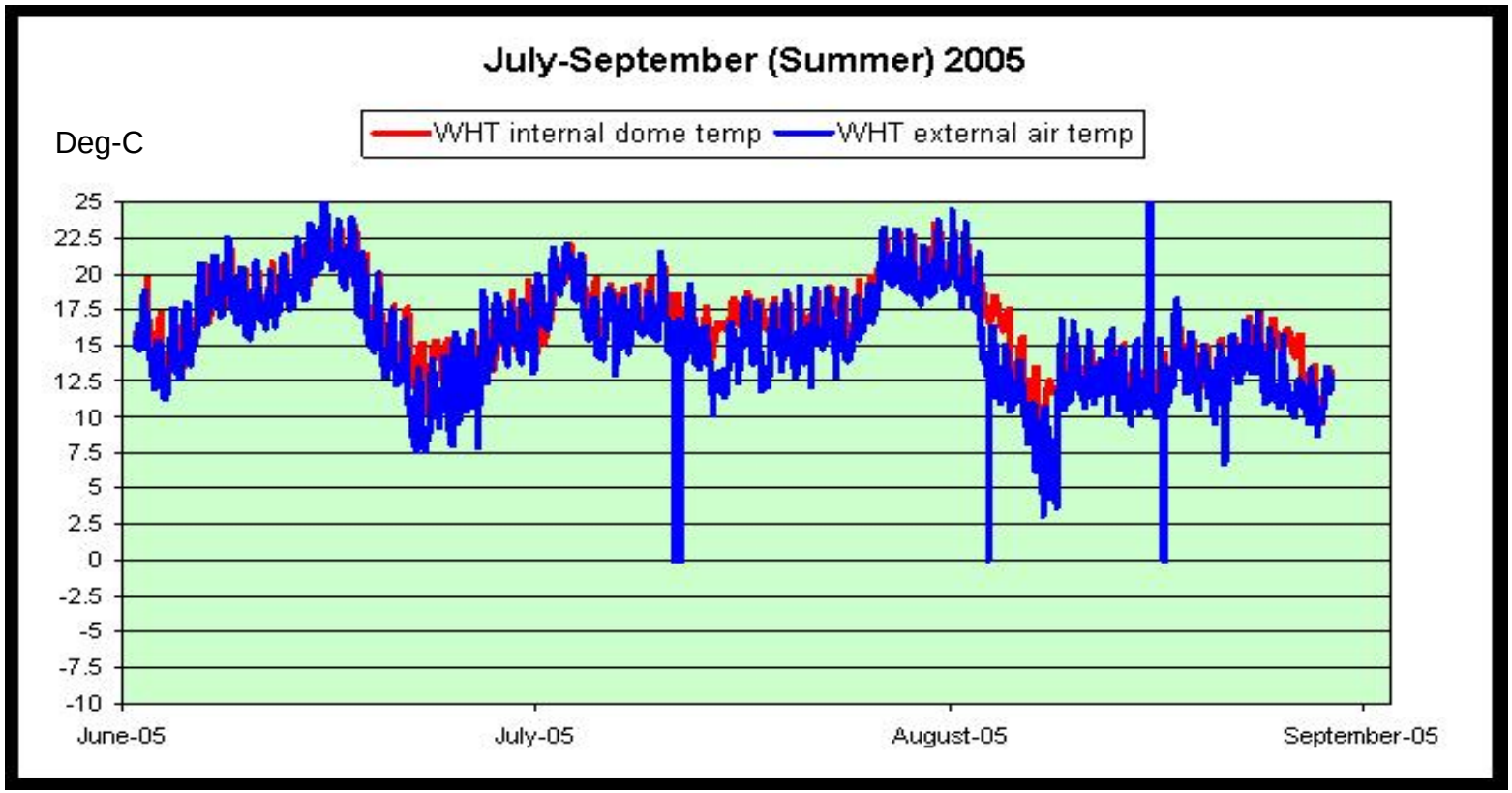
Summer Season



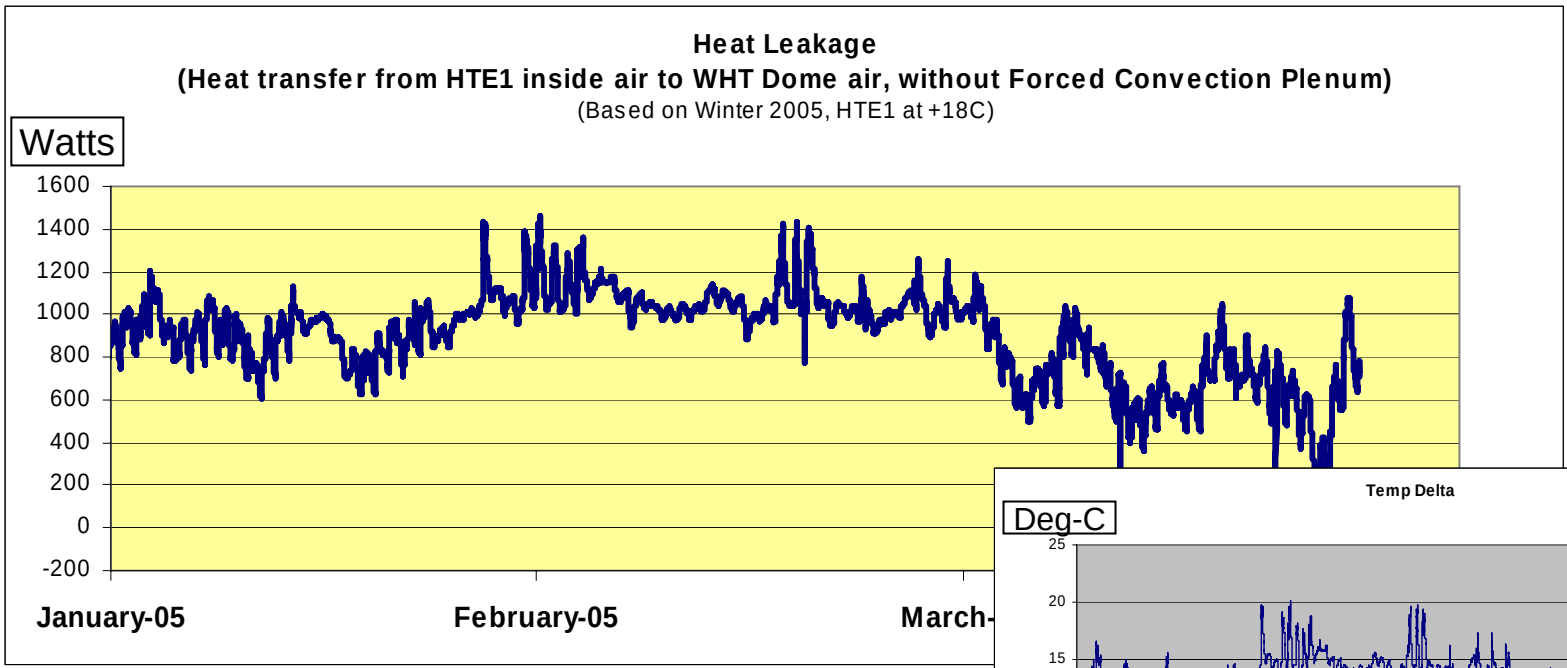
HARPS-NEF: Thermal System Design
HTE1: Active Forced Convection System Required

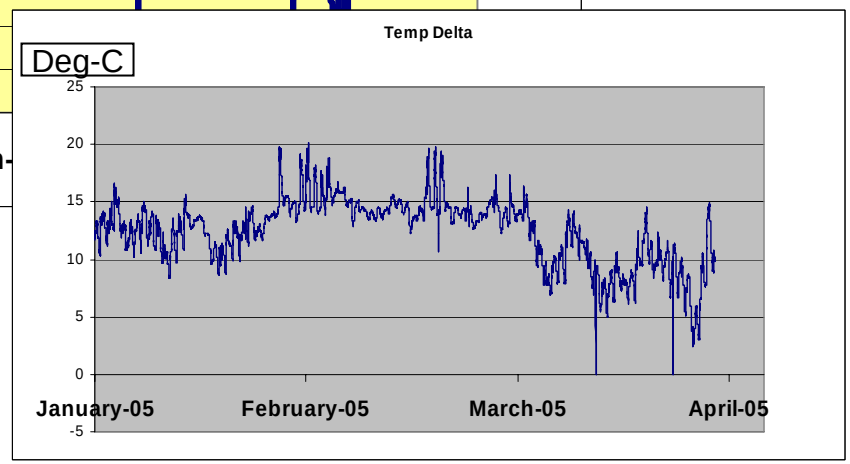
- HTE 1: +18 ±1.5C
  - Primary Requirement:
    - Less than 100w thermal leakage into the dome year around.
  - On the coldest day, temperature differential of 14°C is expected from the internal HTE1 internal temperature to internal WHT dome temperature.
    - “Passive” thermal enclosures will not be able to maintain below 100W thermal leakage requirement.
    - Active thermal system (external plenum air circulation system) is proposed.
  - During the summer season when the dome temperature is greater than +18°C, HTE1 will absorb heat.
    - HTE1 will have air conditioning unit to maintain +18°C.

HARPS-NEF: Thermal System Design

HTE1: Thermal Load, Winter

Baseline Design: 152mm of Aerogel
2x6 metal stud construction at 24” spans





Temp Delta = HTE1 Temp – Dome Temp

HARPS-NEF: Thermal System Design

HTE1: Thermal Load, Summer

Baseline Design:

152mm of Aerogel

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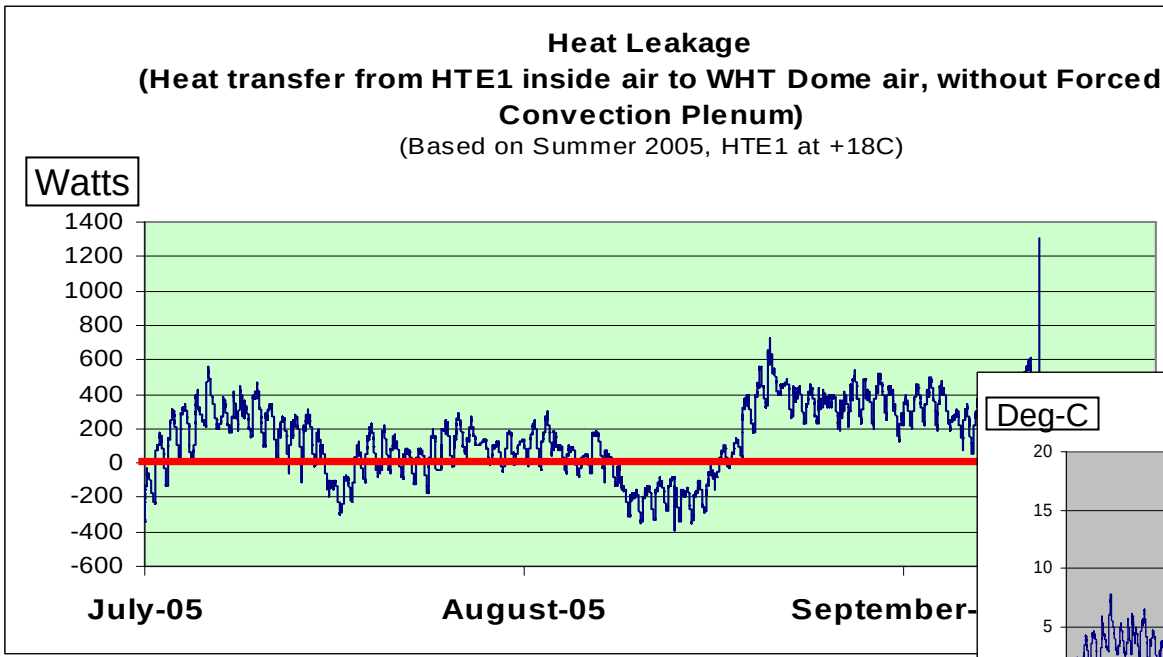
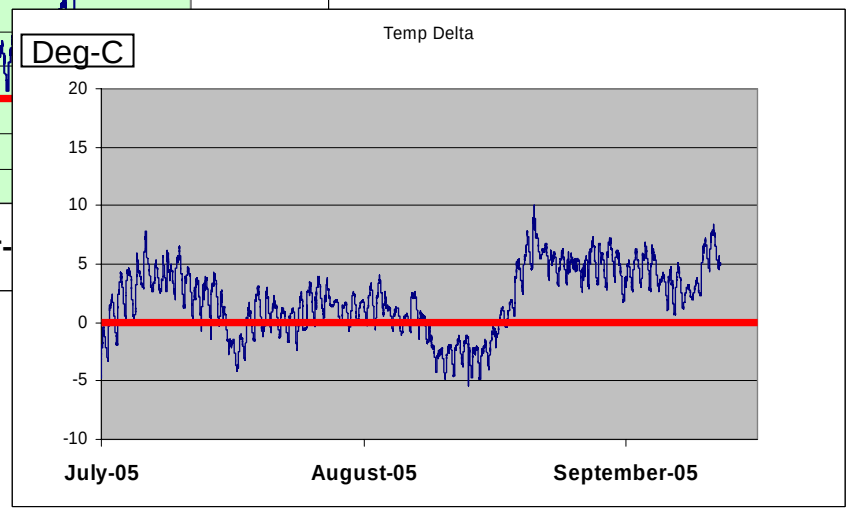


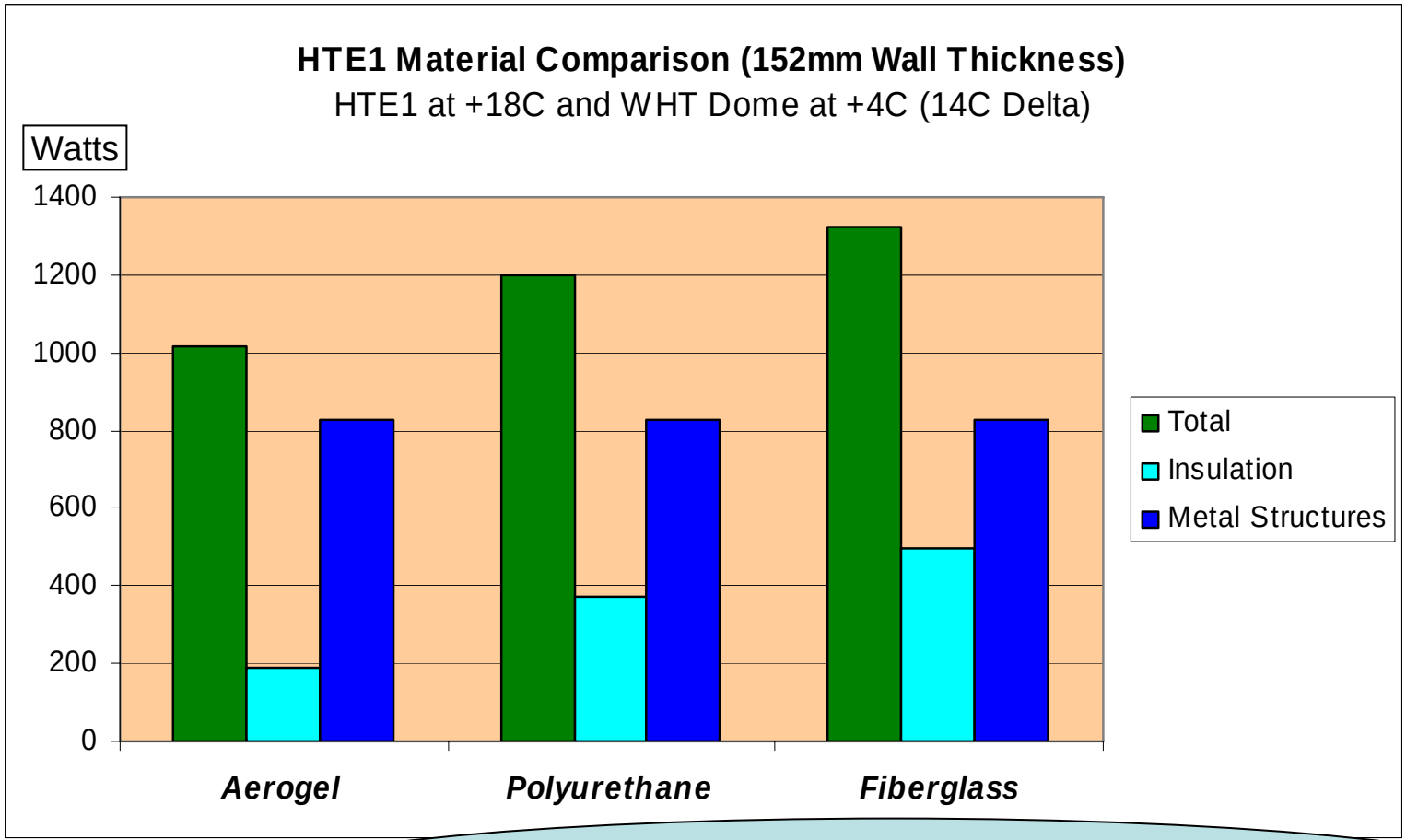
Less than 400watts
Heat Leakage
During the summer season



Temp Delta = HTE1 Temp – Dome Temp

HARPS-NEF: Thermal System Design

HTE1: Material Comparison

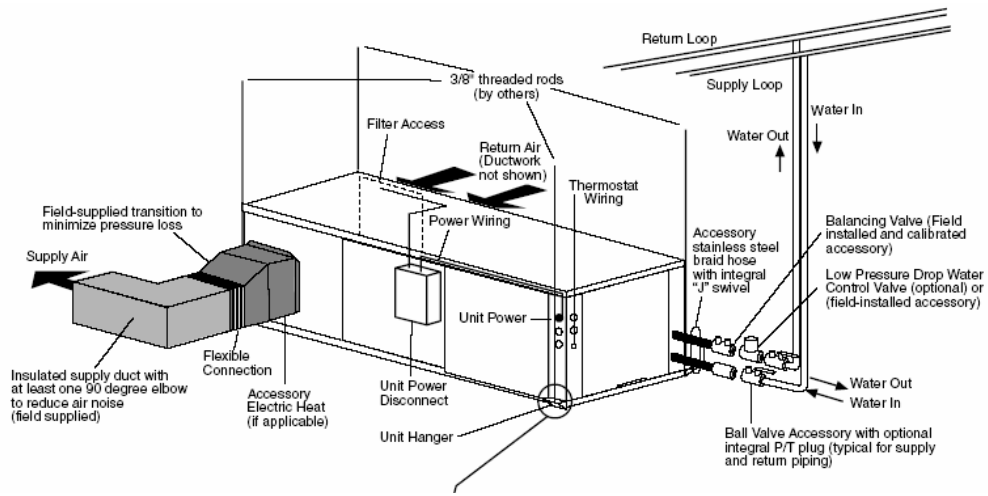


Design will reconsider alternative structural material/design to reduce heat leakage through the frames

HARPS-NEF: HTE1 Thermal Systems

HTE1:

- Insulated walls (6 inches/152mm) with double outer skin air plenum jacket (6 inches/152mm max.).
- Self contained heating, air conditioning, and circulation unit, regulated to +18 ±1.5 °C.
  - Commercial self-contained unit (Carrier):
    - Liquid cooled Condenser: 4.5gpm (17.1 ℓ/min)



HARPS-NEF: HTE1 Thermal Systems

- Results: based on 1st QTR 2005 Dome Temperatures.
  - 1000watts (budget) loss through insulated walls and through joint/stud conduction.
  - Outer skin plenum design to extract heat away from the internal dome (approx. 4500 CFM or 128m^3/min).
  - Less than 0.5°C rise in exhaust air temperature from the ambient temperature on the coldest day.
  - Less than 30watts impact to dome heat load during the coldest dome temperature (+4C). Most of the heat will be exhausted to the outside air.
    - ~300% margin reserved
  - Diffuser/Louvers/screens mounted at the exhaust.
    - Options: HCO or WHT fans

HARPS-NEF: Thermal Systems

HTE2:

- Self contained Liquid Chiller will handle heating and cooling, regulated to +15 $^{\pm}$0.2 °C.
- Liquid to Air Tube-Fin Heat Exchanger with fans, 600 CFM x2 (1200CFM Total, 34 m^3/min), for internal air circulations.
  - 30 seconds air re-circulation time (120 re-circulations/hour of contained air volume to minimize temperature gradients)
  - Air ducts (inlet and outlet) to maintain uniform flow coverage

- Insulated Walls, 4 inches (102mm) thick polyurethane with aluminum skins.

HARPS-NEF: Thermal Systems

HTE2: Thermal Control System Chiller Capabilities

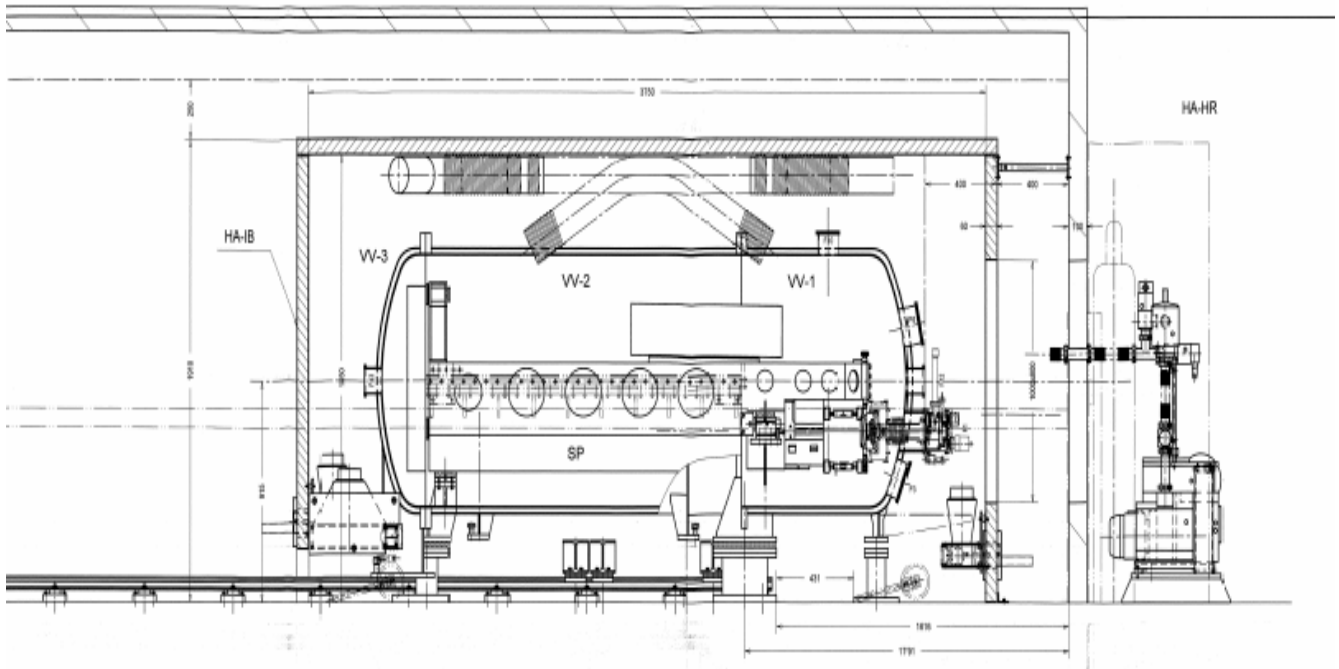
Liquid cooled: 1.5 gpm
5.7 ℓ/min

- **Standard temperature range** 5° to 35°C
- **Ambient temperature range** 13° to 35°C
- **Stability** +/- 0.1° C
- **Condenser** water cooled
- **Reservoir size** 8 Gallons/ 30.3 Liters
- **Cooling capacity** 50 Hz at 20°C 3,735 W
- **Pump performance** 50 Hz Pump 2.75 gpm @ 50 psig (PD2)
- **Power requirements** 50 Hz 220-240V1ø
- **Unit dimensions** cm (H x W x D) 103.2 x 66.7 x 53.7
- **Plumbing connections**
  inlet/outlet process 3/4" FNPT 3/4" FNPT 3/4” FNPT(CP-75 1” FNPT)
  inlet/outlet facility (W/C only) 1/2” FNPT 1/2” FNPT 1/2” FNPT
- **Plumbing connection**
  drain 1/2" FNPT 1/2" FNPT 1/2” FNPT
  auto refill 3/8" OD SS barb 3/8" OD SS barb 3/8” OD SS barb
- **Refrigerant** 50 Hz R134A R134A R134A
- **Compliance** 50 Hz units CE CE CE
- **Unit weight** kg 145.2

HARPS-NEF: Thermal Systems

HTE3: GO Supplied / Proven Capability

- Self contained heating and circulation unit, regulated to +17 ±0.01°C.
- 60mm of polyurethane insulated walls with aluminum skins.



- **Floor will be insulated (to be discussed).**

HARPS-NEF: Electronic Racks

- Thermal Management
  - Power Dissipation Budget: 1500w Total
  - Sealed enclosures with liquid heat exchanger and dedicated chiller.

Summary

- WHT Facility requirements:
  - Facility Electrical: approximately 30Amp at 240VAC
  - Facility Coolant: 7.5 gpm/28.5 ℓ/min (10gpm/38ℓ/min reserve)
  - Facility modifications, if any
    - May require ducts to bridge from the HTE1 outer plenum to the facility exhaust system.