Quench Module Insert (QMI) and Diffusion Module Insert (DMI) Furnace Development

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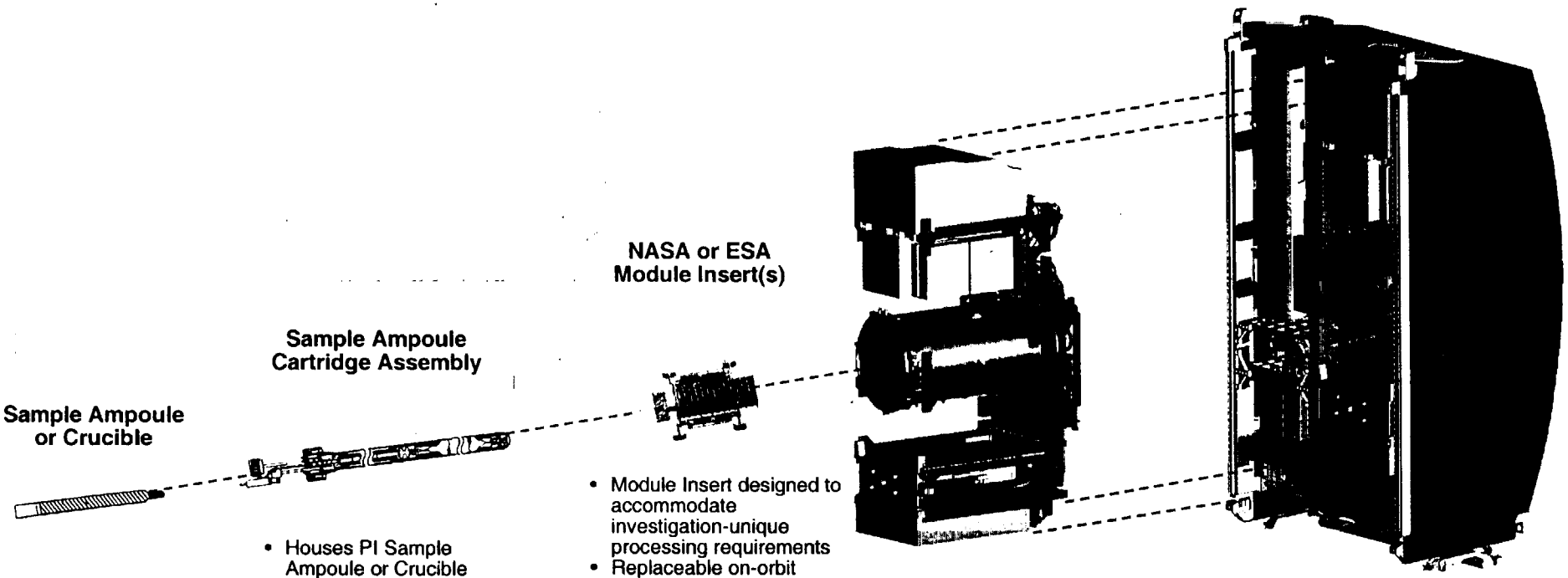
Furnace Module in Rack



- Contains "Sample" to be processed
- Sealed
- PI provided

- Houses PI Sample Ampoule or Crucible
- Sensors for monitoring temperature and Cartridge integrity
- Loaded into the Module Insert by crew
- Sealed to provide one-level of containment

- Module Insert designed to accommodate investigation-unique processing requirements
- Replaceable on-orbit
- Provides for 'Automatic' processing
- Vacuum or inert atmosphere

MSL Experiment Module Accommodates Various Module Inserts

ESA Provides
- Power Supply
- Avionics/Control System
- Data Electronics
- Core Facility
- Gas/Vacuum distribution sub-system
- Water pump package
- Gas Supply

MSRR-1

SPD EM + **MSL EM**

- NASA provides Rack Subsystems
- NASA integrates the Rack Payload

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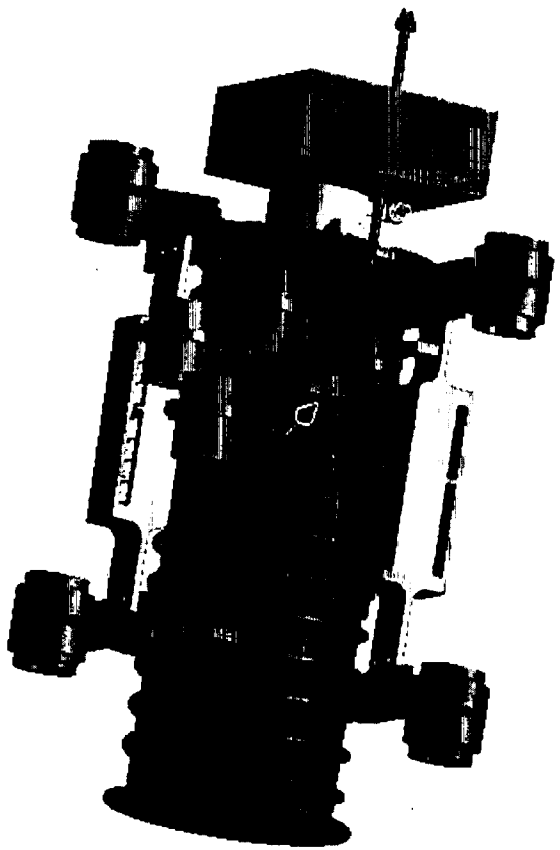
Quench Module Insert

- **Objectives** - A multi-user Bridgman furnace Module Insert for MSRR-1 providing high gradient directional solidification with rapid quench intended for metals & alloys processing.

- **Planned Launch :** UF3

- **Hardware Features / Capabilities:**
  - Multi-zone vacuum furnace
  - Temp range 400°C to 1400°C
  - Actively cooled cold zone
  - Axial gradient 60°C/cm to 100°C/cm (Design goal 150°C/cm)
  - Sample size up to 10mm in diameter
  - Quench 1/2 cm in axial length in 2 sec
- **Challenges:**
  - Achieving quench rate



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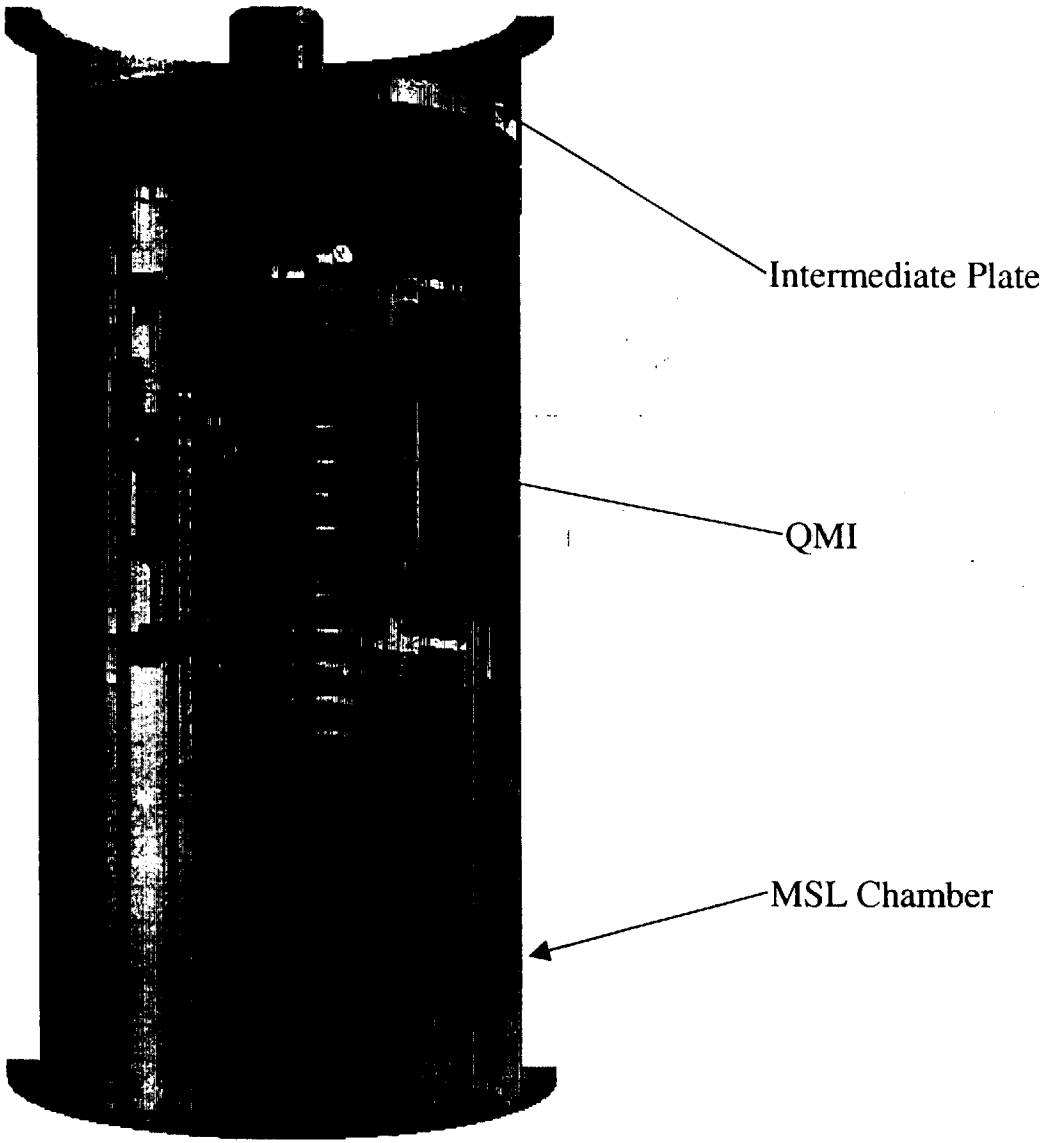
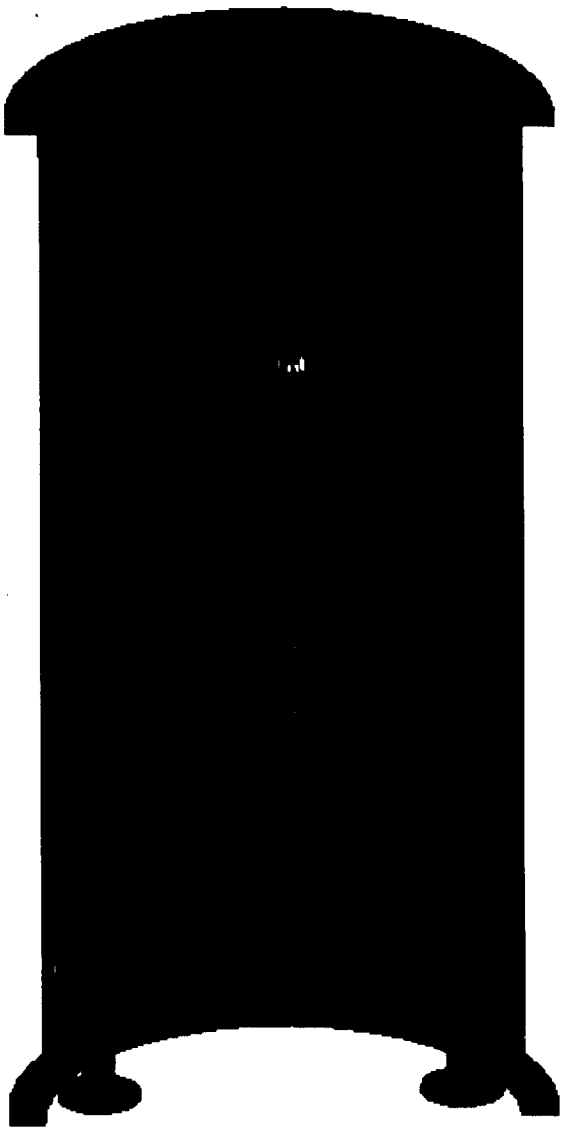
QMI in MSL Core





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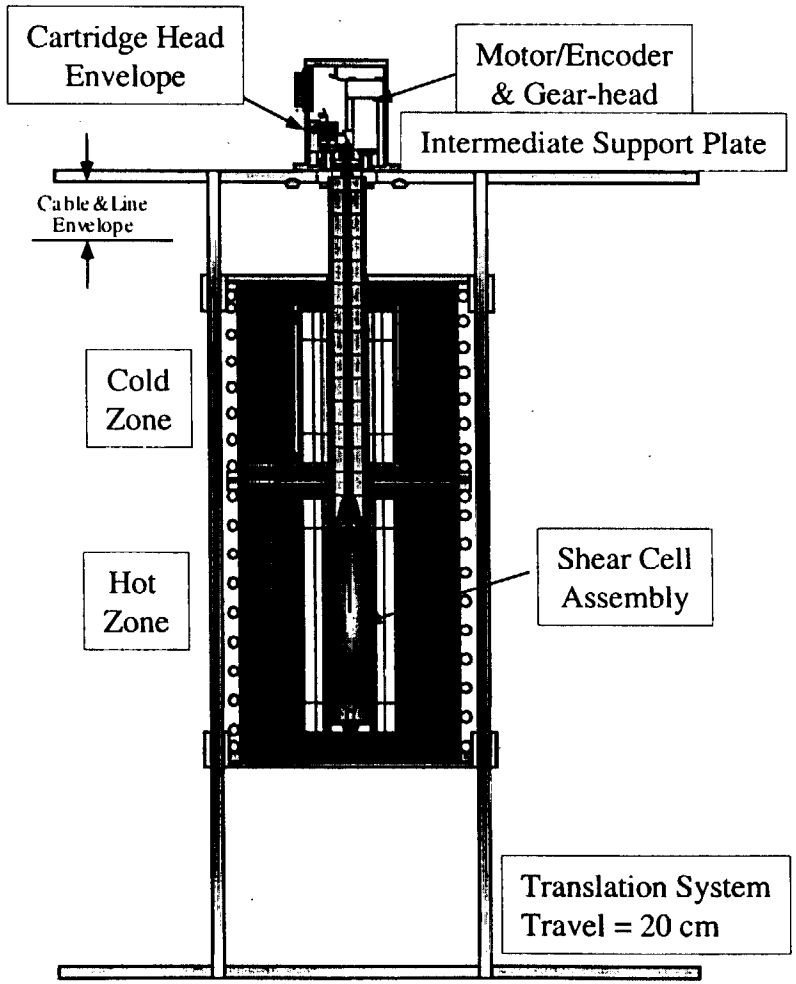
Diffusion Module Insert

- **Objectives** - A multi-user furnace insert for MSRR-1 providing high temperature processing of semiconductor materials with isothermal heated zones for diffusion studies of doped-silicon and germanium using the shear cell method.

- **Planned Launch Date:** FY2004

- **Hardware Features / Capabilities:**
  - Multi-zone furnace, processing range to 1600°C
  - Adiabatic zone between heated zones / axial gradient to 100°C/cm
  - Isothermal length of 10 cm
  - SACA incorporates drive motor / shearing and rotation

- **Challenges:**
  - High Temperature
  - SACA Design



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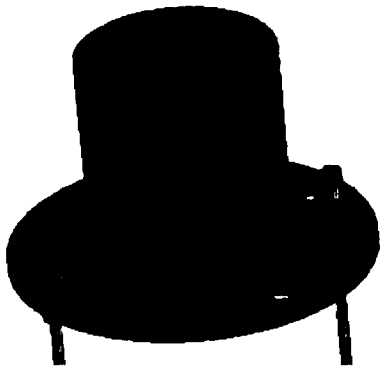
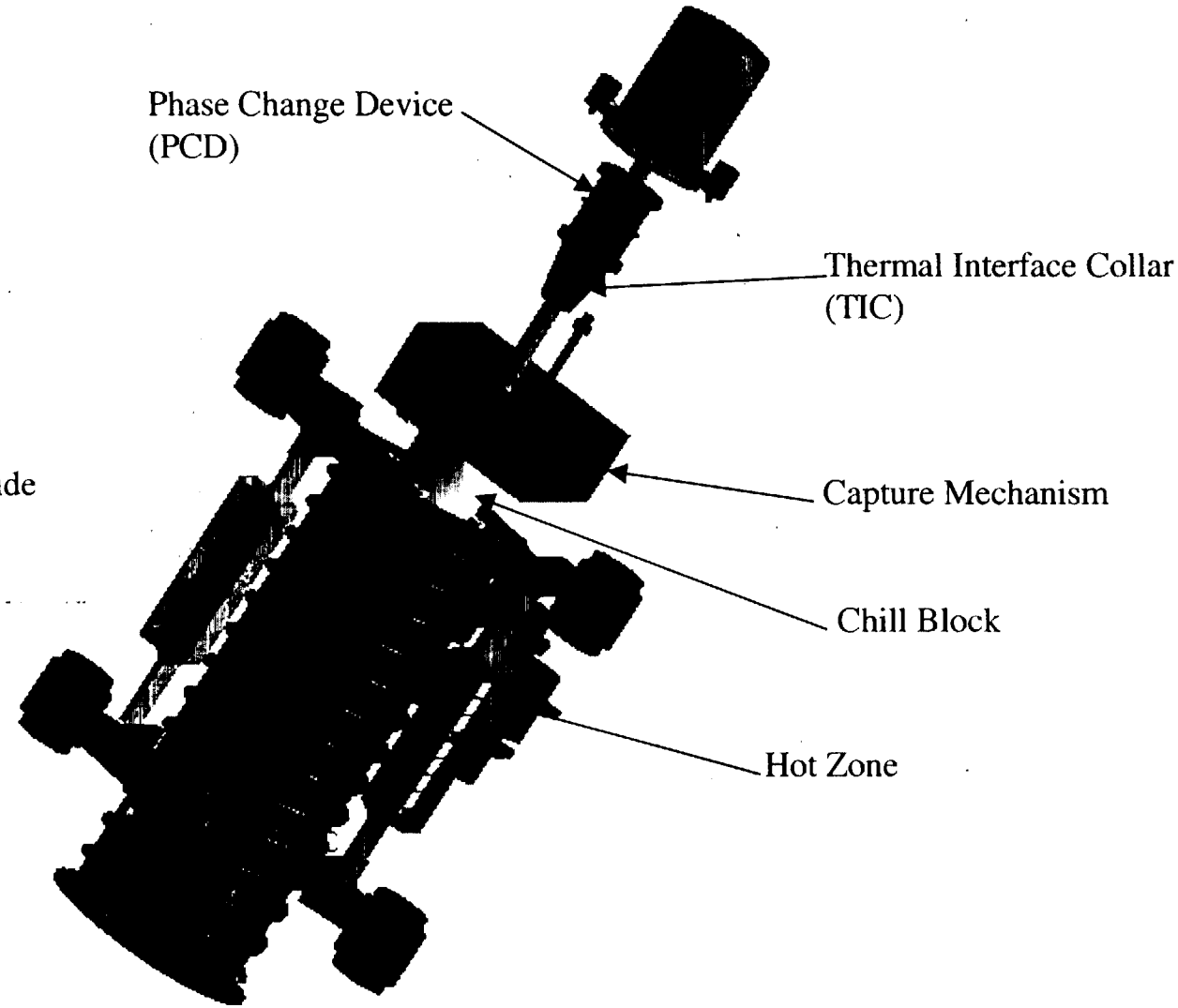
QMI



Borelectric Heater Element
- -Pyrolitic Boron Nitride
- -Pyrolitic Graphite



QMI and DMI Furnace Development

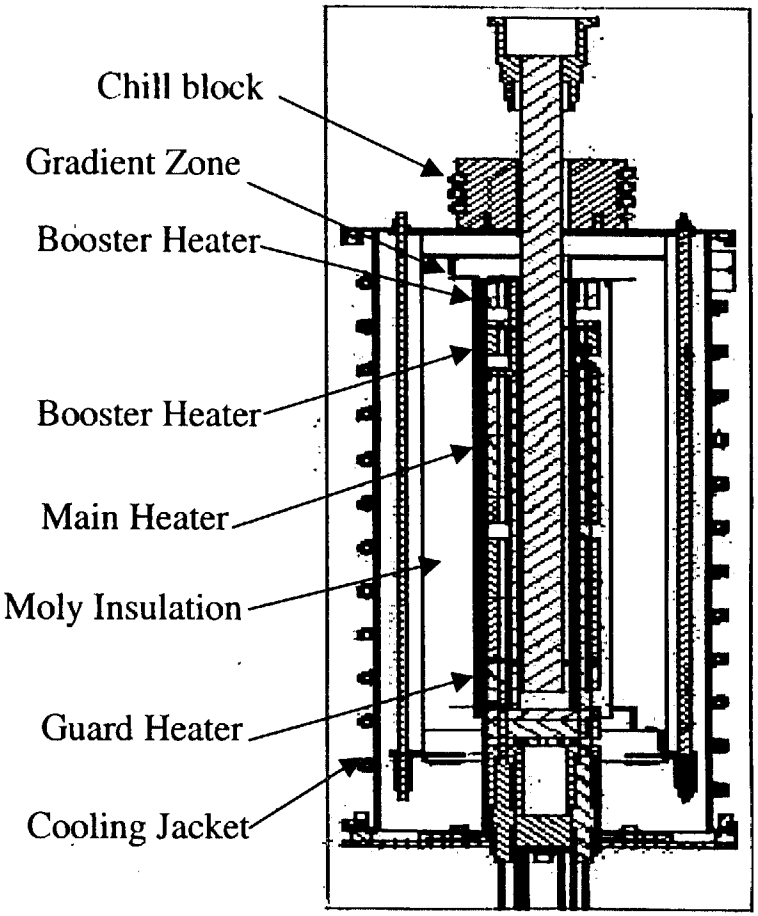
QMI DEVELOPMENT AND TESTING

- **QMI Units Being Developed**
  - HZTA for life issues
  - Bread board for early interface and performance definition.
  - 2 Ground units for science definition and ground processing
    One unit for NASA, one unit for ESA
  - 1 Flight unit and 1 Flight back up

- **Development Testing**
  - Hot Zone Test Article
  - Chill block
  - Phase Change Device

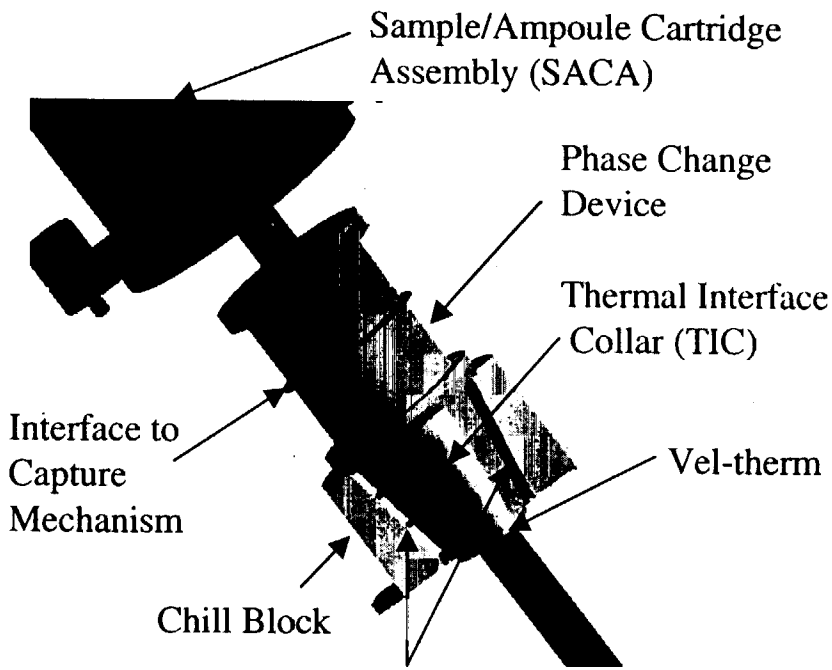
QMI DEVELOPMENT AND TESTING

- **Hot Zone Test Article**
  - Built to understand heater element life
    - Life of 8000 hours over 5 years
    - Concerns time at temperature and number of heating cycles
  - Automated facility has conducted multiple cycles based on currently defined PI timelines
  - Testing will continue to failure or 8000 hours whichever is later
  - Testing includes periodic inspection of hardware
- **Heater to Lug Transition**
  - Separate life test of transition from heater element to wiring
  - Tantalum wire, lug, nut creep



QMI DEVELOPMENT AND TESTING

- **Chill Block**
  - High Gradient Requirement
  - Actively cooled Chill Block with Thermal Interface Collar utilizing Vel -Therm to achieve intimate contact with SACA
  - Testing to establish effective heat rejection capabilities of Vel-Therm in a vacuum environment
    - Obtained 400 W/mK to support gradient design goal of 150 C/cm



Chill Block/TIC Interface

QMI DEVELOPMENT AND TESTING

- **Phase Change Device**
  - Rapid Quench Requirement
  - Phase change material used to effect quench
    - Unique concept utilizing reduced resource requirements
    - Ground testing confirmed performance exceeds requirements for heat extraction
    - KC135 testing for low-g impacts
      - Performance not sensitive to low-g influences