
BEAM TUBE BAKEOUT SAFETY PROCEDURES

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BEAM TUBE BAKEOUT

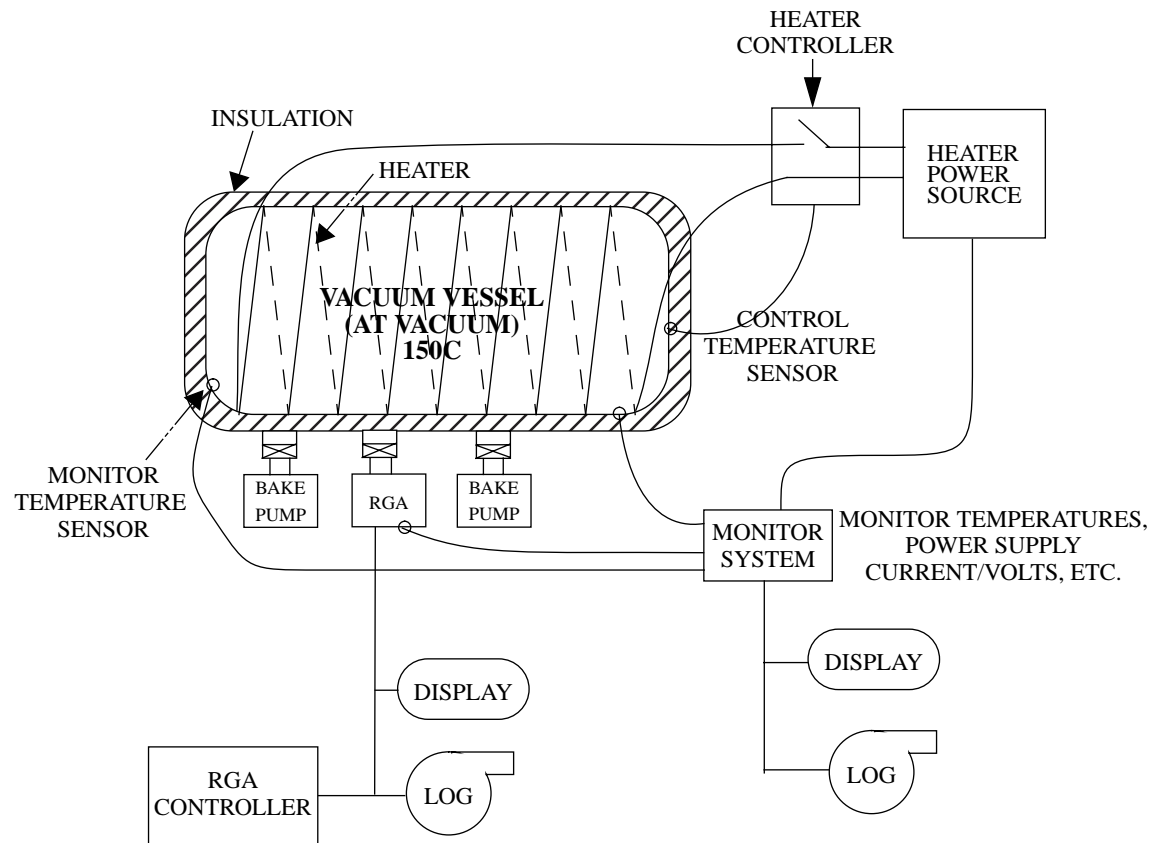
- Bakeout Objectives

- ›› Reduce H₂O, CH₄, CO, CO₂, etc. outgassing to achieve partial pressures less than LIGO goal level (10^{-10} torr for H₂O, corresponds to strain noise of 2×10^{-25} Hz^{-1/2})
- ›› Reduce outgassing of contaminating hydrocarbons to minimize risk to interferometer optics

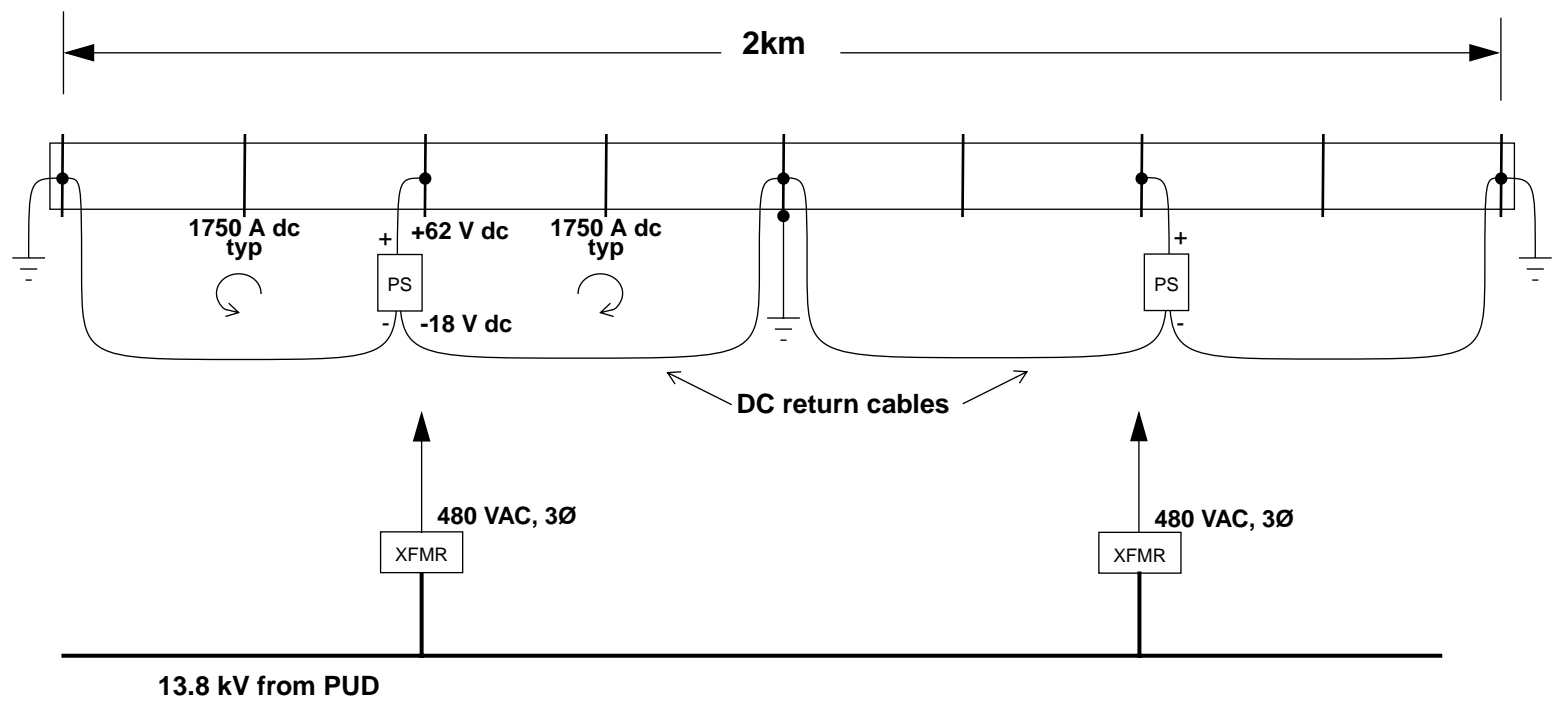
- Method

- ›› Heat beam tube modules to 150 °C for 30 days under high vacuum

EQUIPMENT CONFIGURATION DURING BAKEOUT



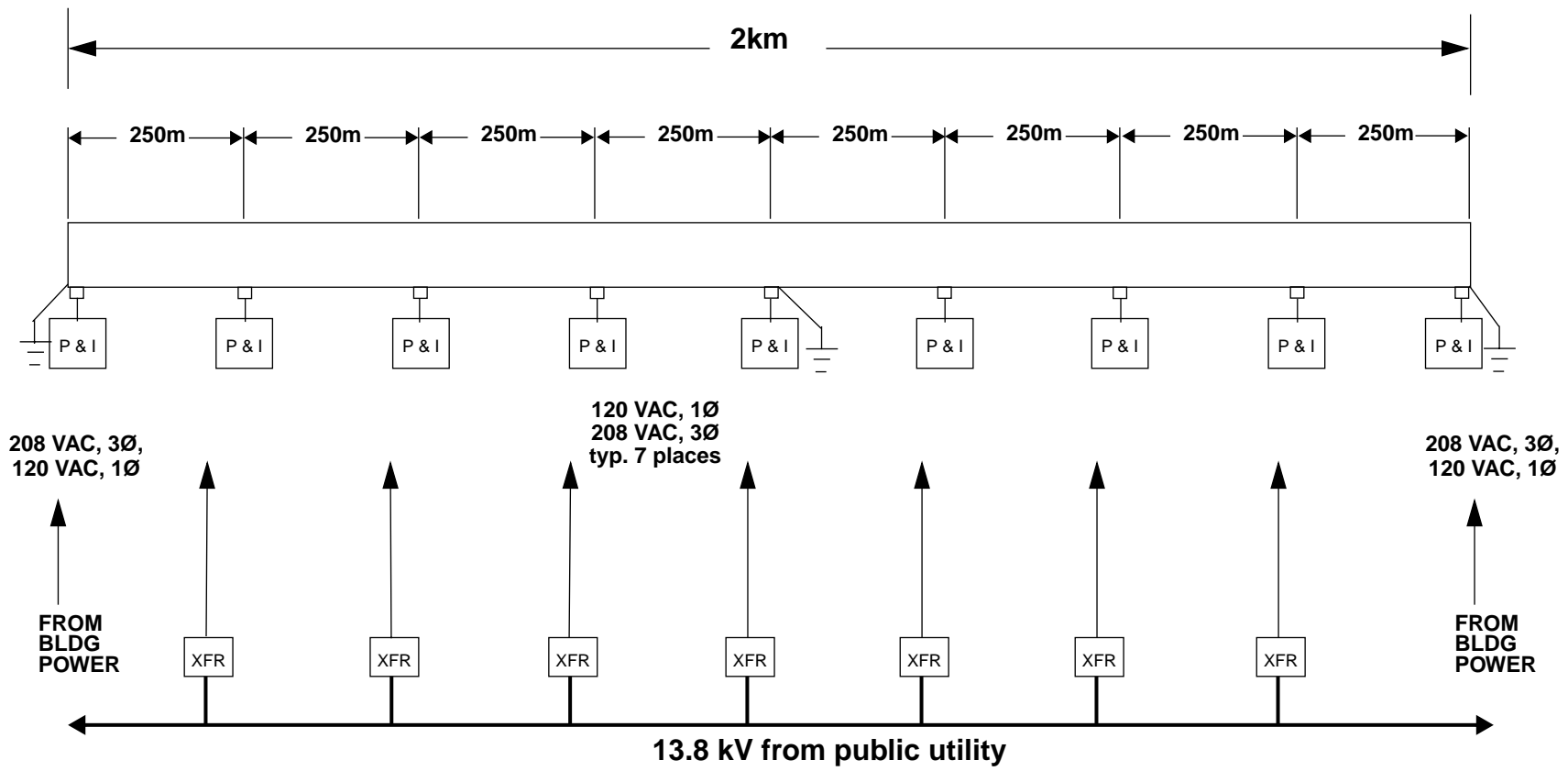
BEAM TUBE BAKEOUT ELECTRICAL HEATING POWER



- Legend:**
- PS Low voltage, high current DC power supply
 - XFMR Power Transformer



ELECTRICAL POWER FOR HEATER JACKETS, PUMPS AND INSTRUMENTATION

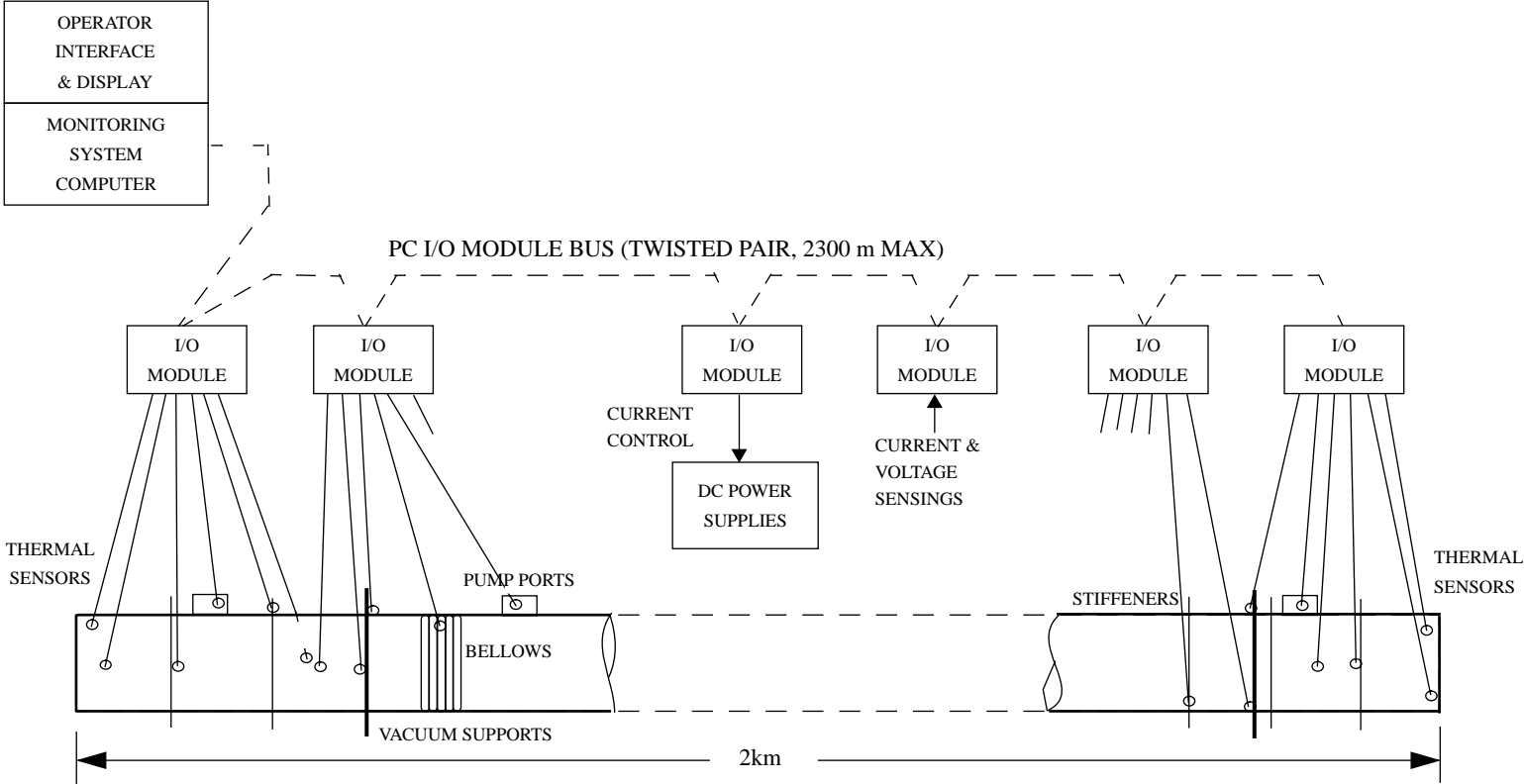


Legend:

- Pump Port
- P & I Pumps & Instrumentation



MONITORING SYSTEM



BAKEOUT STATES

1. Pre-bake - DC power not connected to tube
2. Pre-bake - DC power connected to tube
3. Bake
 - 3a. Equipment end-to-end checkout
 - 3b. Ramp up temperature
 - 3c. Hold temperature
 - 3d. Ramp down temperature
4. Post-bake - DC power disconnected
 - 4a. Temperature stabilization - cryopumped
 - 4b. Pumped at one end only, bake and post-bake RGAs installed
 - 4c. Pumped at one end only, post-bake RGAs installed
5. Post-bake - connected to and pumped by Vacuum Equipment

BAKEOUT PLAN

- Conduct first 2 km module bakeout to:
 - ›› Validate insulation, heating and pumping designs
 - ›› Evaluate beam tube mechanical behavior during bake
 - ›› Shakedown the setup, bakeout and post-bake procedures (and maybe the post-bake leak localization and repair procedures)
- Iterate procedures and designs as needed
- Bake 3 remaining modules at Hanford, ship equipment to Louisiana, and bake 4 modules
- On-site staffing:
 - ›› Site scientist/engineer to supervise setup, bakeout, data evaluation
 - ›› 2 site technicians for equipment installation, checkout and removal
 - ›› 4 temporary technicians for 1-person-24 hr. bake monitoring

BEAM TUBE ENCLOSURE ENTRY PROCEDURE

- Special bakeout-specific lock tumblers installed at doors
- Part A - for use near grounded ends of beam tube
 - ›› Operator issues BLUE key and logs entry and exit
 - ›› User returns key to operator after work is completed
- Part B - for use at all other doors
 - ›› Operator sets DC power supply voltage to zero
 - ›› Operator issues GREEN key and logs entry
 - ›› User locks out power supply nearest work point
 - ›› After work is performed, user unlocks and turns on power supply, then returns key to Operator
 - ›› Operator restores power supply operation and logs exit and key return
 - ›› 2-way radio contact maintained throughout operation
 - ›› 2 people required for work away from lighted door areas

POWER SUPPLY EMERGENCY SHUTDOWN

- Bakeout Operator sets power supply control to zero
- If that is imprudent or doesn't work, push EMERGENCY STOP buttons on each DC power supply (mounted outside for ready access)

OTHER BAKEOUT SAFETY MEASURES

- Lighting in work areas
- Flashing beacons at access doors during operation
- Flashing beacons at emergency exits inside beam tube enclosure
- Signs on all access doors and electrified equipment
 - ››NO ENTRY - EMERGENCY EXIT ONLY on all single doors except at ends
 - ››DANGER - HOT on all double doors and at ends
 - ››DANGER - ELECTRICAL HAZARD - AUTHORIZED PERSONNEL ONLY on double doors at ports 2, 3, 4, 6, 7, and 8
 - ››DANGER - HIGH VOLTAGE on cryopump stands at ports 2, 3, 4, 6, 7, and 8
- CO2 fire extinguishers at each pump port (including ends)
- Ethylene glycol (PS coolant) storage, handling and spill cleanup equipment