

# BEAM TUBE BAKEOUT

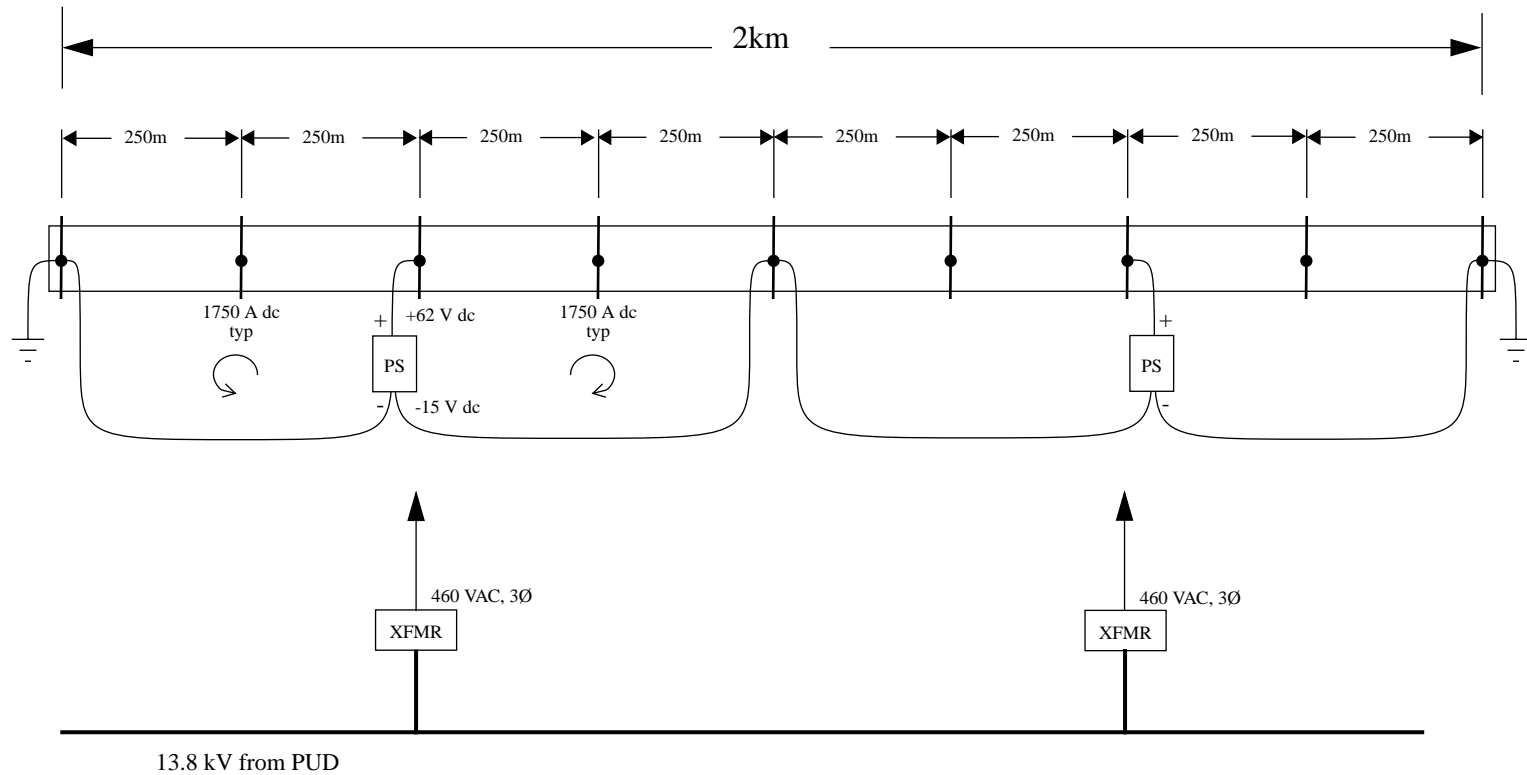
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APRIL 15, 1997

# BEAM TUBE BAKEOUT REQUIREMENTS & OBJECTIVES

- LIGO Science Requirement Document
  - ›› Sets the GOAL for residual gas pressure “... at a level or below an equivalent strain noise of  $2 \times 10^{-25} \text{ Hz}^{-1/2}$ ”
  - ›› GOAL level supports future advanced interferometers (additional pumping may be used if needed)
  - ›› Initial interferometer requirement is much more relaxed
- Bakeout Objectives
  - ›› Reduce  $\text{H}_2\text{O}$ ,  $\text{CH}_4$ ,  $\text{CO}$ ,  $\text{CO}_2$ , etc. outgassing to achieve partial pressures less than LIGO goal level ( $10^{-10}$  torr for  $\text{H}_2\text{O}$ , corresponds to strain noise of  $2 \times 10^{-25} \text{ Hz}^{-1/2}$ )
  - ›› Reduce outgassing of contaminating hydrocarbons to minimize risk to interferometer optics

## BEAM TUBE BAKEOUT ELECTRICAL HEATING POWER



### NEED FOR TUBE HEAT<sup>1</sup> -

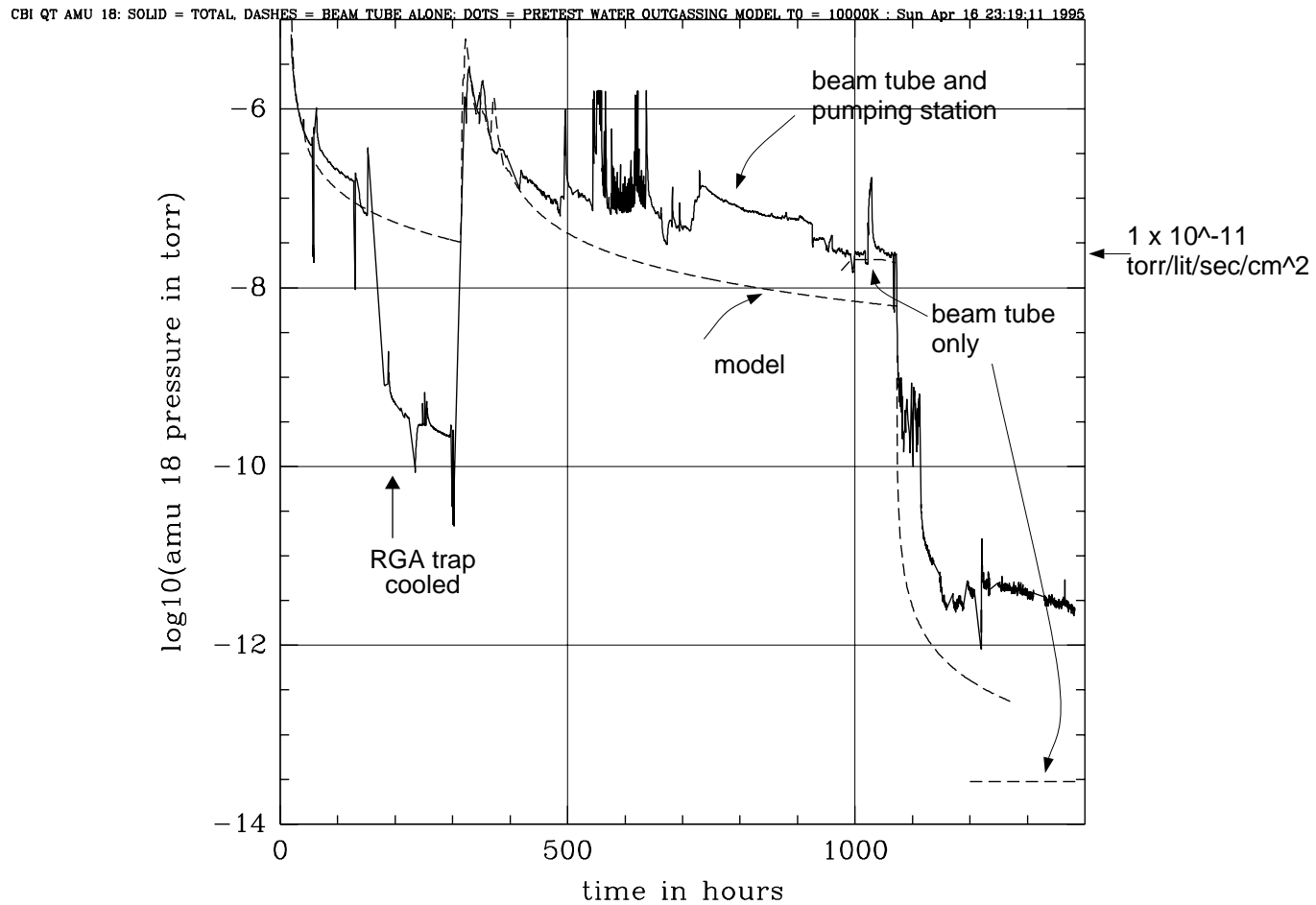
- 2 x 400 kVA = 800 kVA (summer days)
- 2 x 460 kVA = 920 kVA (summer nights)
- 2 x 505 kVA = 1010 kVA (winter nights)
- 2 x 550 kVA = 1100 kVA (coldest winter nights)

<sup>1</sup>Additional power required for pumps, instrumentation, auxiliary heating

### Legends:

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

# H<sub>2</sub>O PRESSURE - QT BAKEOUT

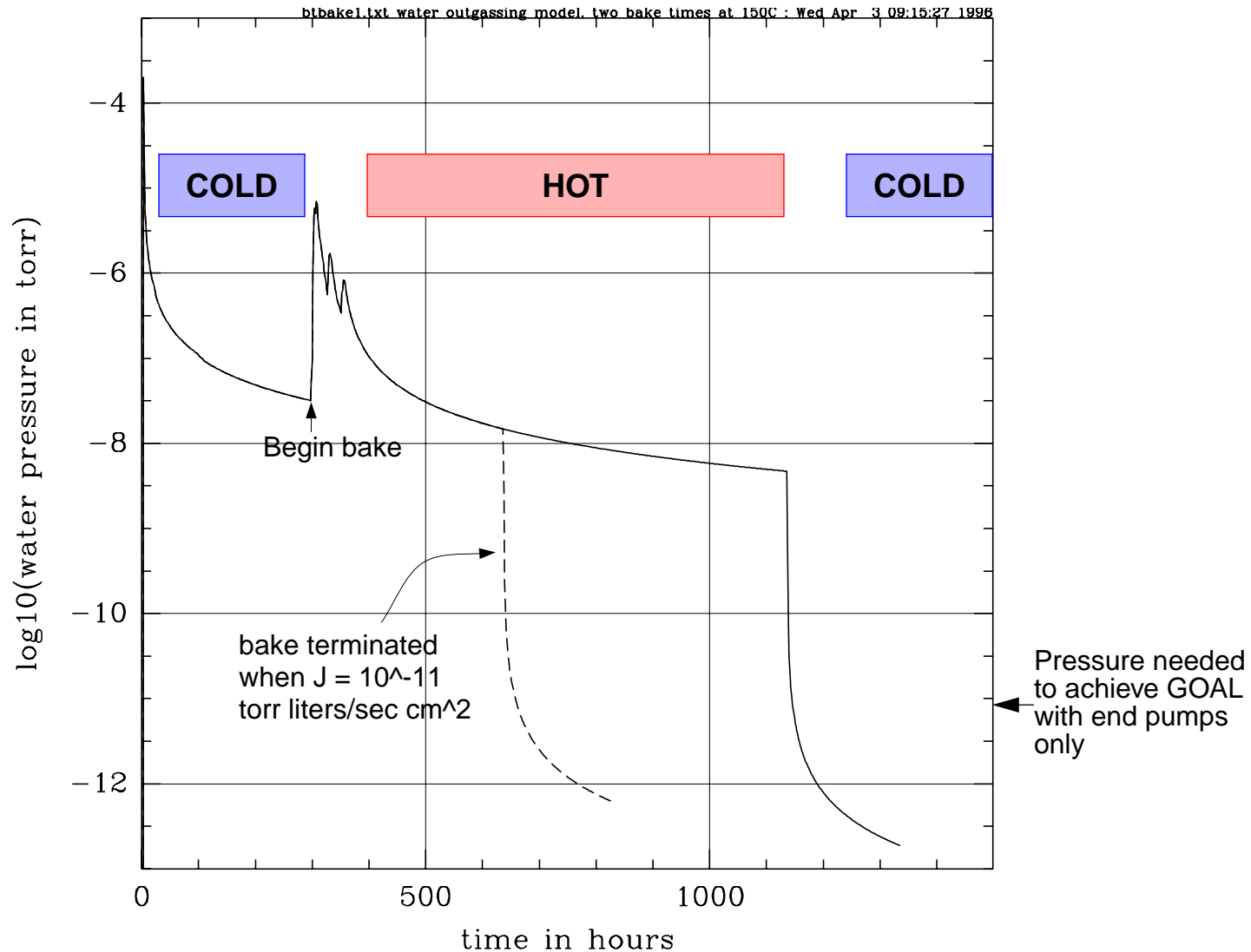


COLD

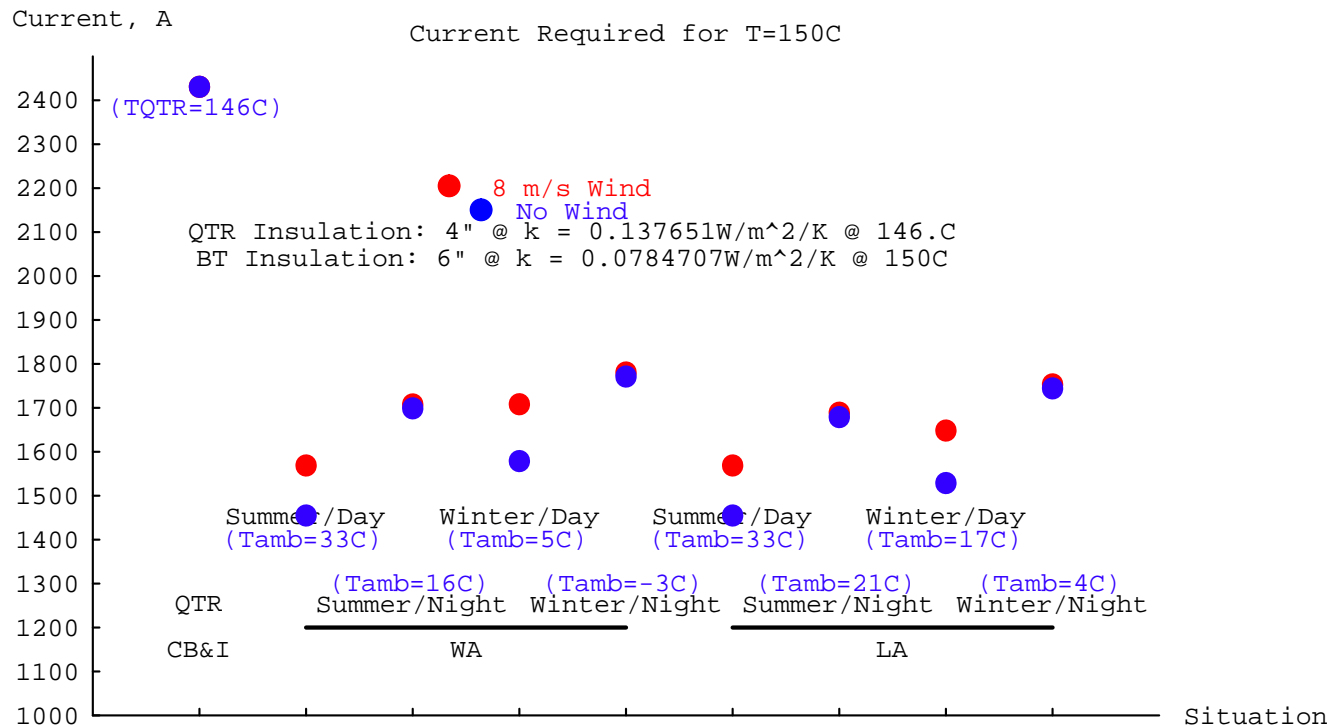
HOT

COLD

# H<sub>2</sub>O PRESSURE REDUCTION MODEL



# BAKEOUT POWER MODEL



# BAKEOUT PLAN

- Conduct bakeout without interference with CBI and PSI installation activities
- Schedule bakeouts so that on-site LIGO staff can handle setup and execution
- 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

# STAFFING & SUBCONTRACTS

- On-site staffing requirements:
  - ›› Site scientist/engineer to supervise setup, bakeout, data evaluation
  - ›› 2 site technicians (2 m-yr. per site) for equipment installation, checkout and removal
  - ›› 4 site or temp. technicians, 1.5 m-yr. per site for 1-person-24 hr. bake monitoring
- Subcontracts:
  - ›› Insulation contractor: purchase, prepare and install beam tube insulation
  - ›› Power company: furnish, install and connect temporary transformers for primary AC power
  - ›› Electrical contractor: install and connect DC power source and auxiliary AC power for pumps, instrumentation and controls



# IN-HOUSE VS. SUBCONTRACTED BAKEOUT

- Advantages to carrying out the bakeout with on-site staff
  - ›› First module bakeout conducted like a scientific experiment - our “only” beam tube is at risk
  - ›› Appropriate scientific and engineering expertise already “mobilized” on site
  - ›› Experiences of on-site technical support staff during bakeout will remain with and benefit LIGO
  - ›› Reduced possibility of interference with other on-site activities
- Found no advantage to subcontracting the bakeout
  - ›› Not a standard subcontracting item/activity
  - ›› Insulation/equipment costs same (equipment will be recycled into LIGO operations activities)
  - ›› Labor costs higher per m-hr (contractor overhead and profit) and experience disappears after completion

**"X" ARM Baffle Installation**

APRIL 1997

**SUMMARY INTEGRATED SCHEDULE**

