H1 arm cavity g factor changes resulting from 1064 nm heating

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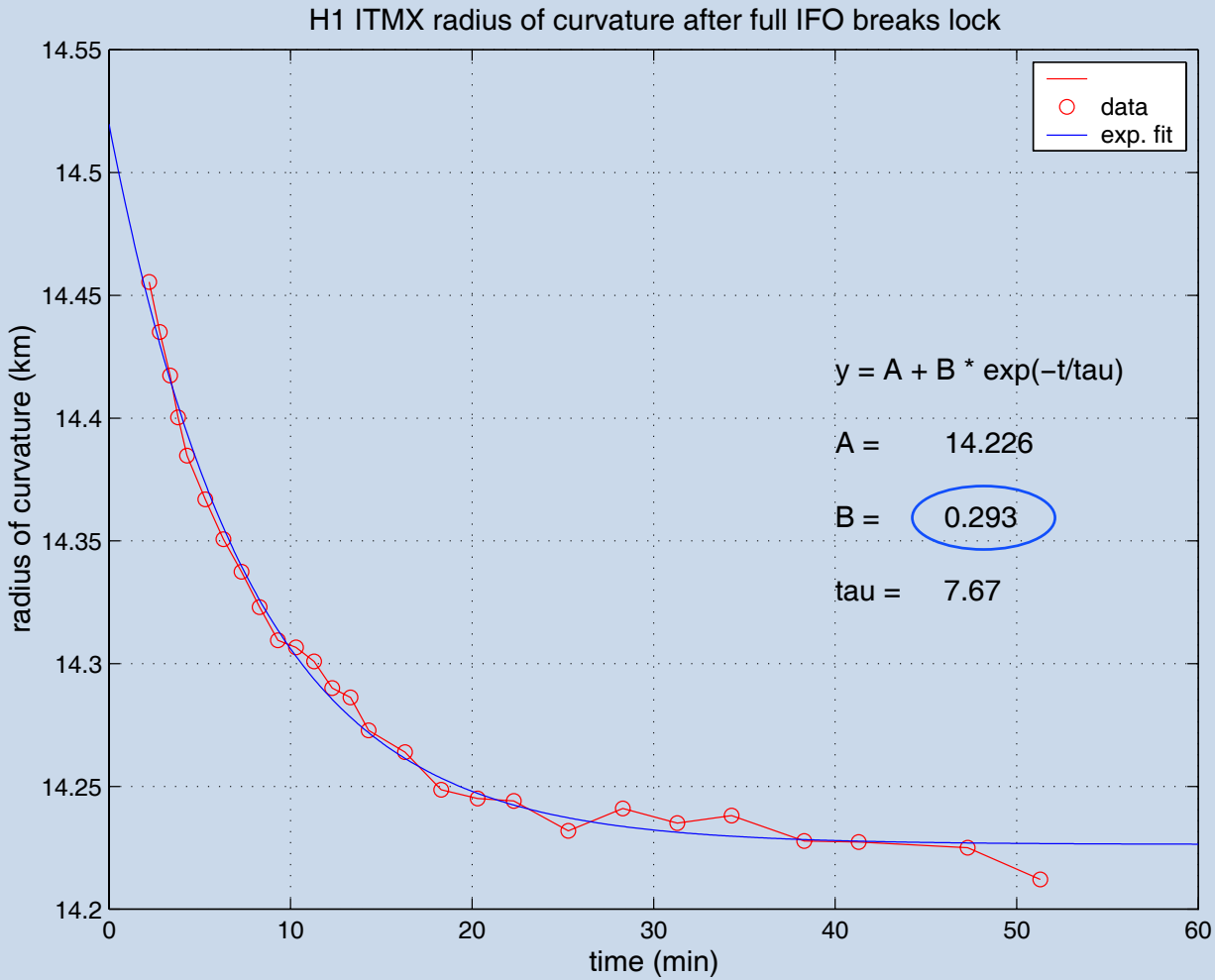
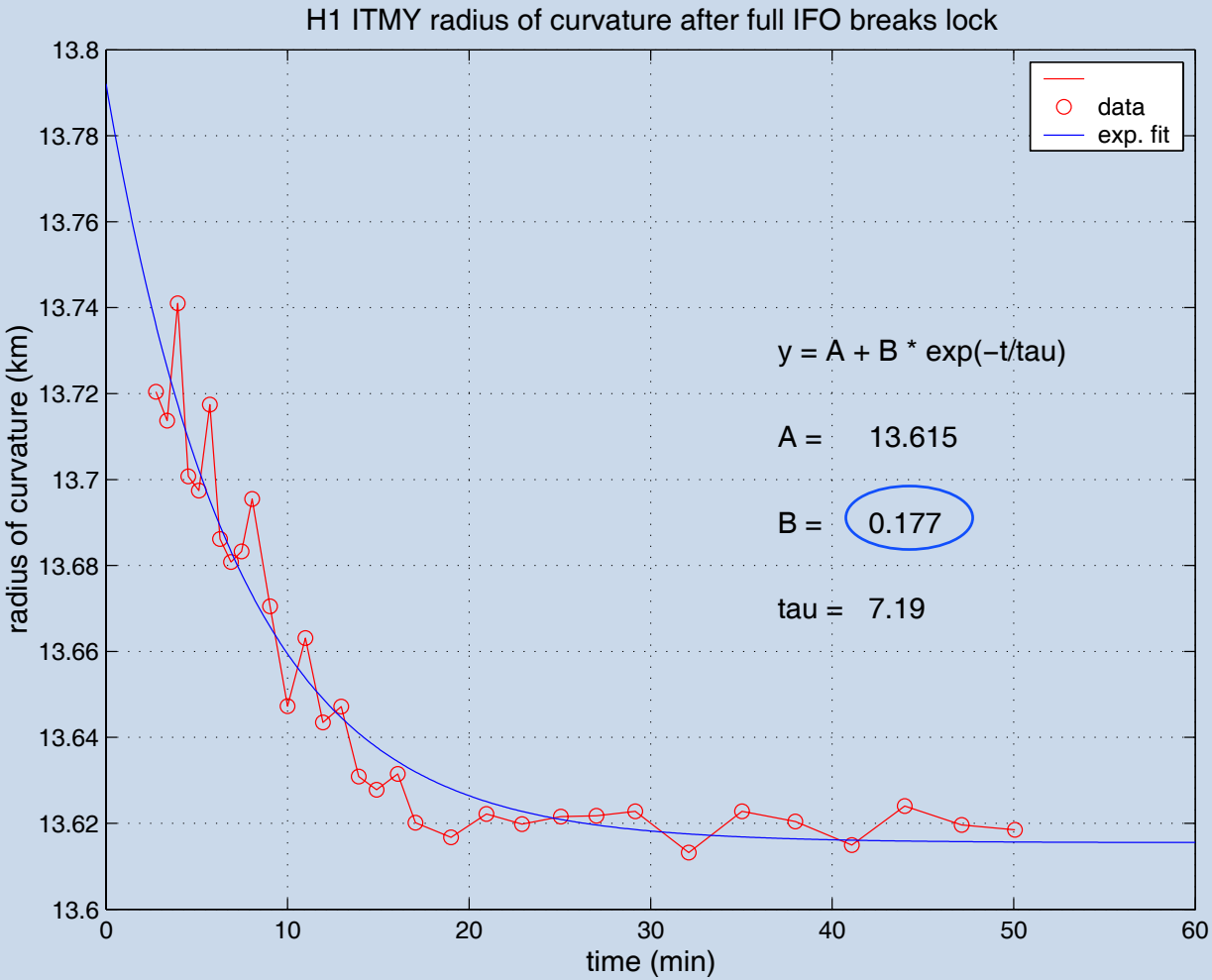
Overview

- Measurement technique described during Detector Commissioning meeting on Feb. 14, 2005 (LIGO-G050076-00-W). $f_{tm} = f_{01} - f_{00} = (f_{fsr}/\pi)\ \mathrm{acos}\ (g)^{1/2}$
- Previous measurements described include TCS heating of ITMs with annulular and central heating.
  - » Hope to use those measurements to calibrate g factor change created by known amount of power absorbed on ITM ***surface.***
- To assess heating with 1064 nm light
  - » Lock full interferometer for > 2 hours ***without*** TCS heating with 1.9 watts of laser light incident on the MC (remember H1 MC trans ~ 80-85%)
  - » Break full lock, lock single arm, misalign MMT3 in yaw, measure $H_{\omega}(f)$ transfer function vs. time
  - » Assume ETM curvature remains at value measured by fabricator (ROC: ETMx = 7260 m, ETMy = 7320 m)
  - » Attribute full g factor change to ITM ($g = g_1\, g_2$; $g_i = 1\text{-}L/R_i$)

Xarm measurement Feb. 18, 2005



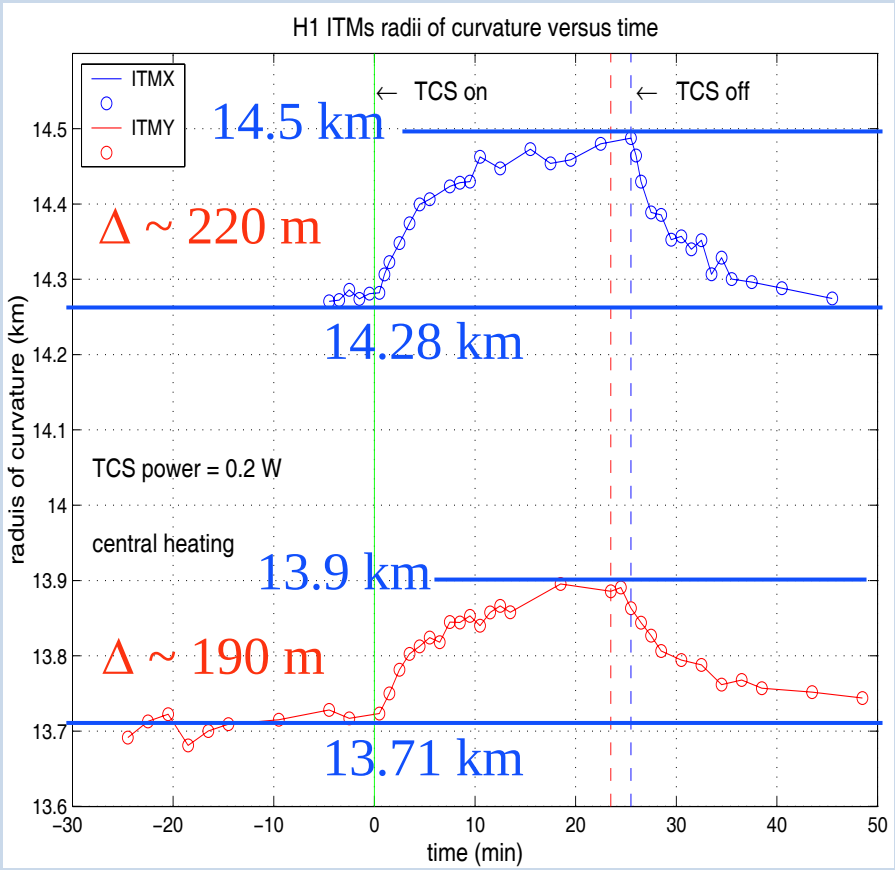
Yarm measurement Feb. 19, 2005



Comparison

- **Note**: unlike TCS heating measurements, where only ITM was heated, 1064 nm light resonating in arm cavity heats both ITM and ETM.
- Time constants – simple exponential fit
  τ_{ITMX} = 7.7 min; τ_{ITMY} = 7.2 min (noisy data)
- Change in radius of curvature
  $\Delta R_{ITMX} / \Delta R_{ITMY}$ = 293m/177m = 1.7
  - » g factor change greater in xarm by factor of 1.7
  - » ETM absorptions differ?
  - » ITM absorptions differ?
  - » *If* ITM bulk/surface absorption ratios differ, then absorption ratio could be larger (or smaller)
  - » Joe Betzwieser's POY and POX time-depentent spot size measurements

Calibration using TCS results



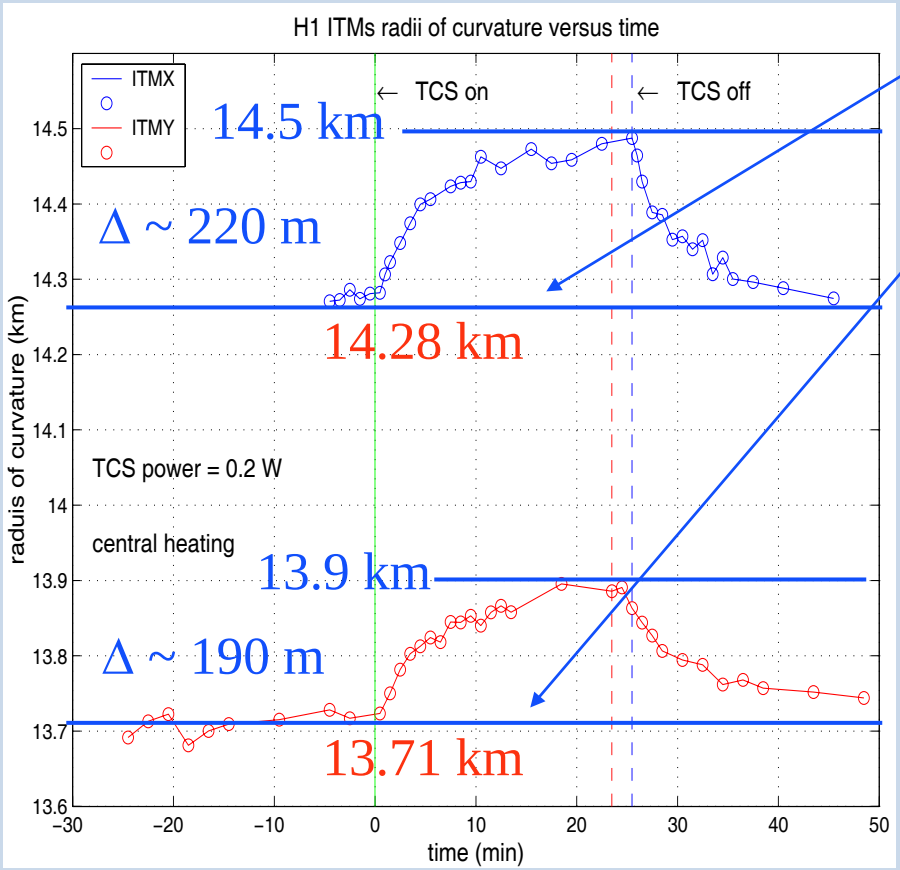
- TCS calibration
  Xarm: 220m / 37mW = 5.9 m/mW
  Yarm: 190m / 45mW = 4.2 m/mW
  - » Surface (not bulk) absorption

- 1064 nm heating
  Xarm: 293m / 5.9 m/mW = **49mW**

  Yarm: 177m / 4.2 m/mW = **42 mW**

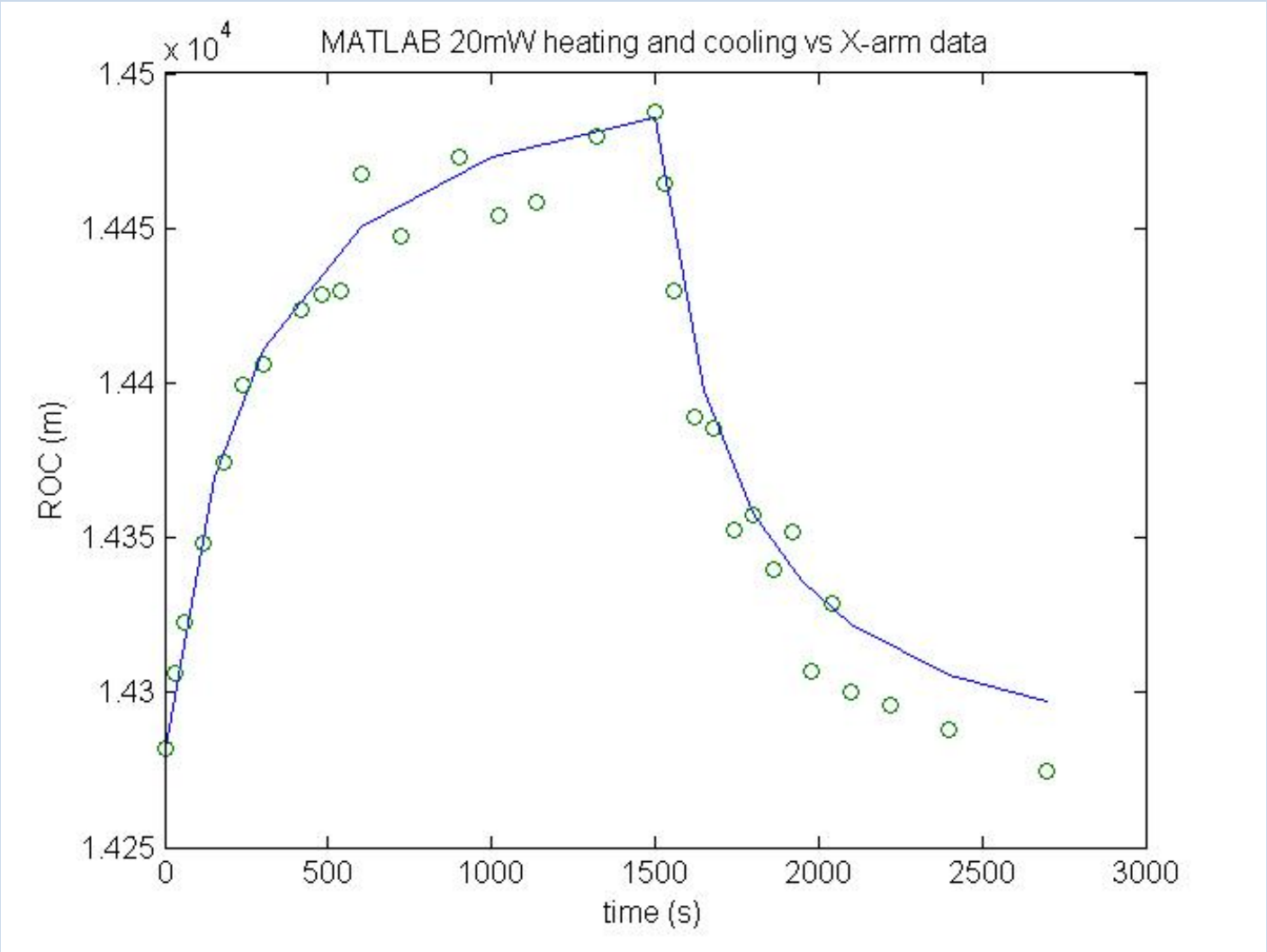
  Assumes all heating on *surface* and no absorption in ETMs
- *Surface-equivalent, ITM-only absorption calibration*

Issues – "cold" curvature differences



- "Cold" values from 1064 nm meas.
  ITMX: 14.226 km
  difference ~ 50 m
  ITMY: 13.615 km
  difference ~ 100m
- Systematic errors?
  - » Alignment drifts – sampling different areas of TM surfaces
- More complex, time-dependent behavior of surface distortions?
  - » Phil Willems studying with time-dependent model of surface distortions
  - » g factor measurements and reduced data available in LIGO-T050030-00-W

P. Willems' time-dependent Hello-Vinet model - Xarm



Yarm comparison