UF coatings damage test facility

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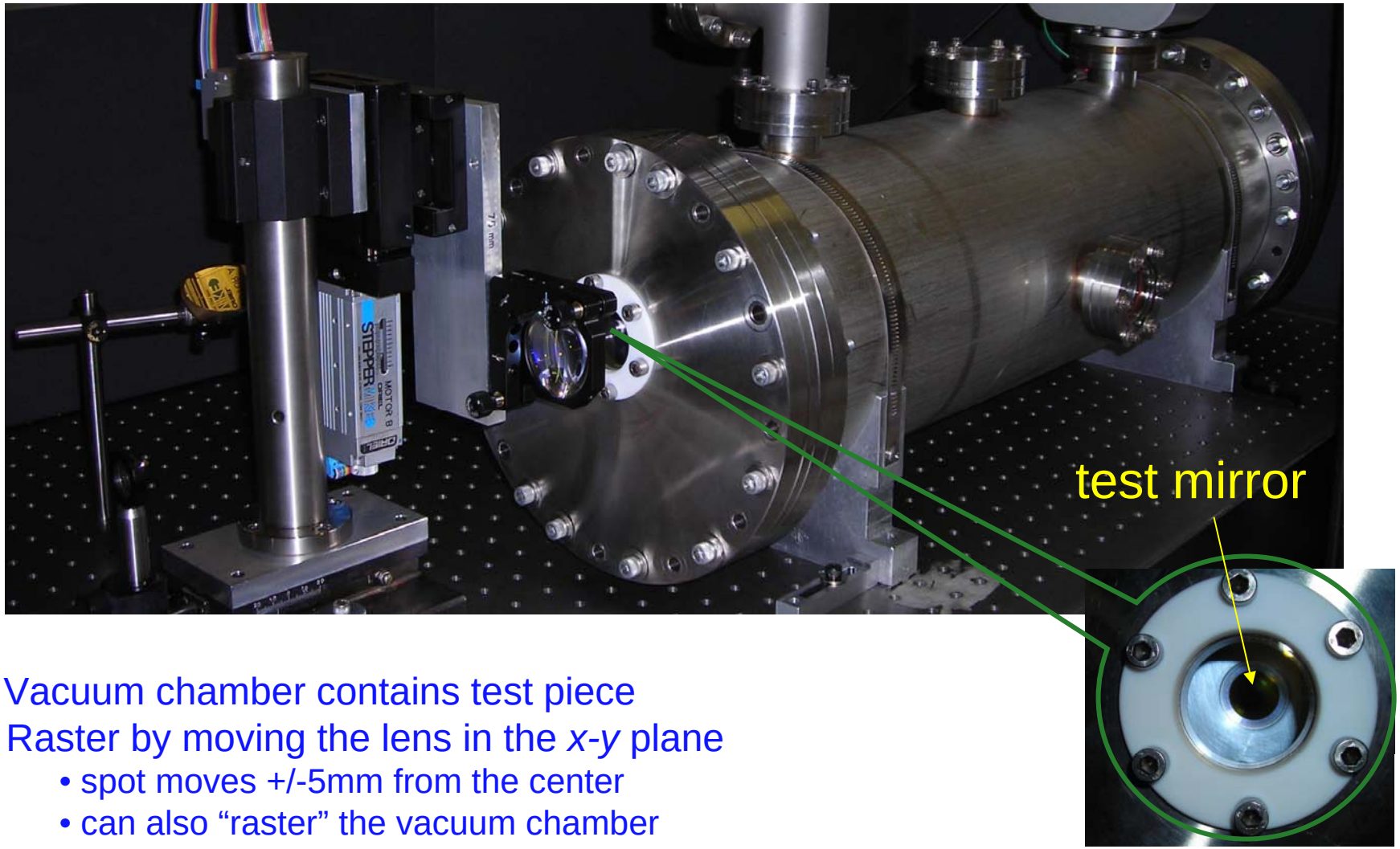
Design requirements

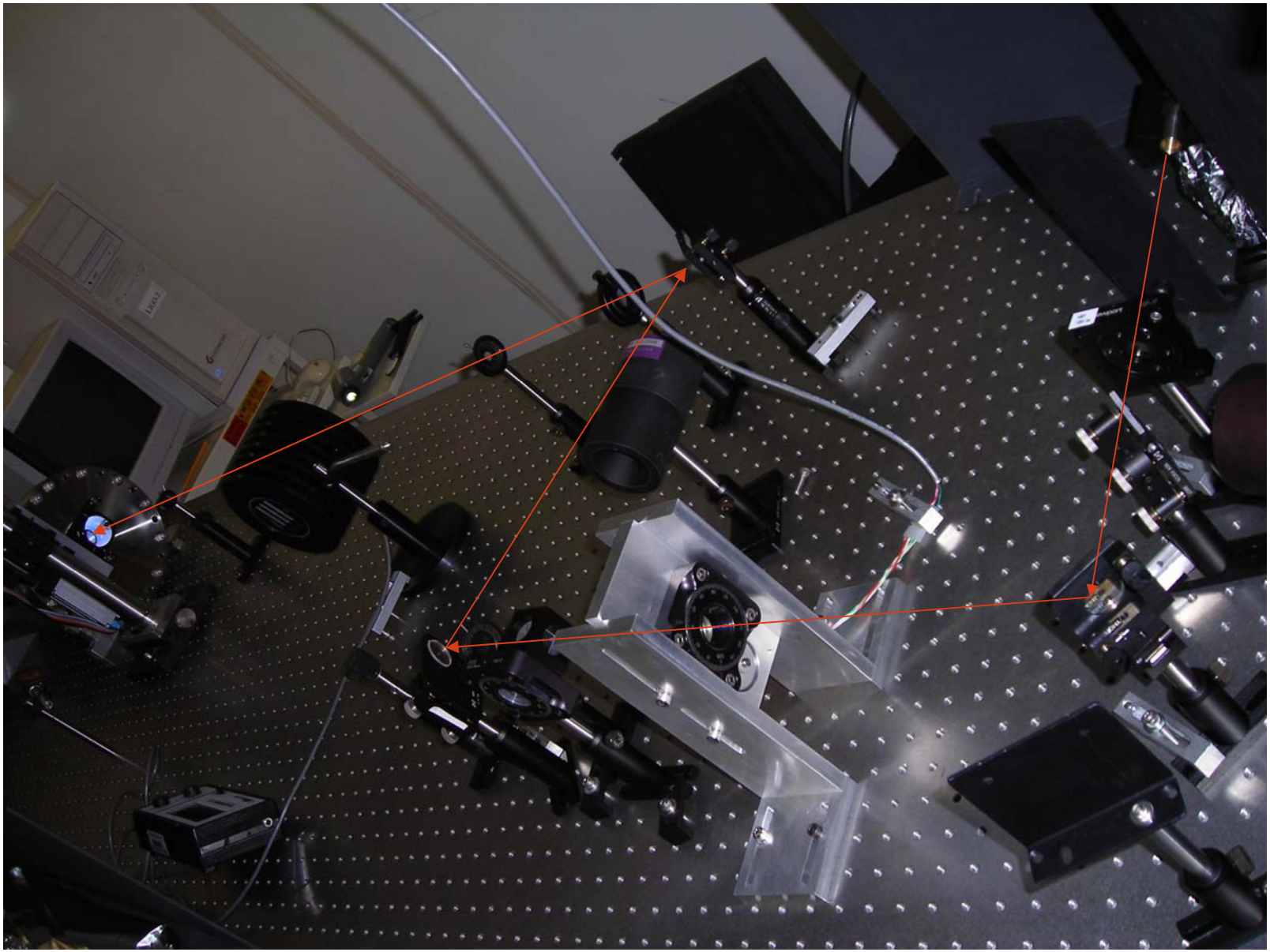
- Subject mirror coatings and materials to conditions that they might encounter in advanced LIGO
- Specifically, IO mirrors
- Input mode cleaner sees ~ 170 kW/cm^2
- 100 W total power (adjustable 0 -> max)
- High intensity (small spot size) (also adjustable)
- Vacuum conditions
- Raster capability for multiple shots on a given coating
- Long duration exposure

Experimental Setup

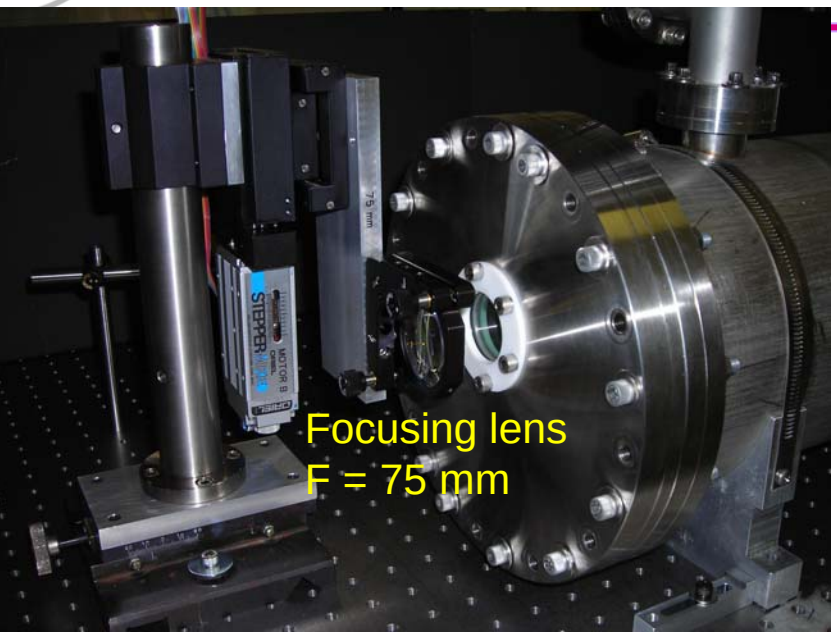


- Vacuum chamber contains test piece
- Raster by moving the lens in the *x-y* plane
  - spot moves +/-5mm from the center
  - can also “raster” the vacuum chamber
- *z* direction manually adjusted (for focus or defocus)
- Checked by observing the reflected beam
  - behind the PBS of the optical diode (slide 5)

Experimental Setup - other views (1)



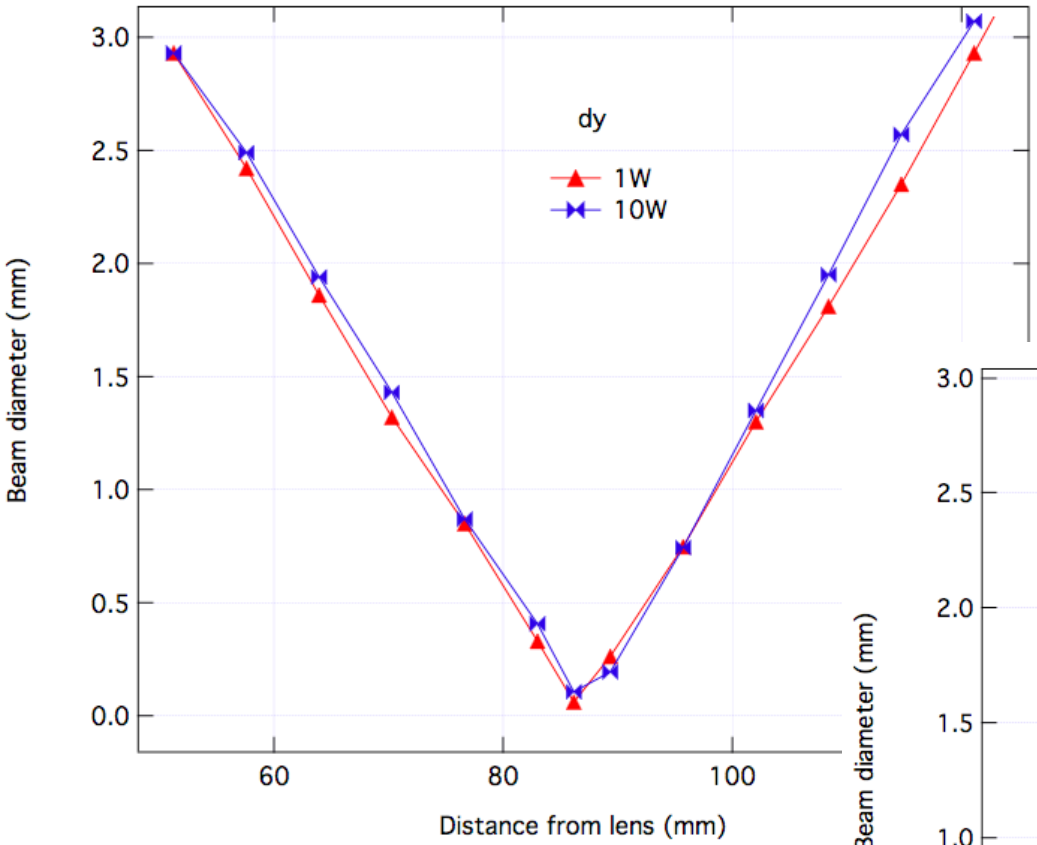
LIGO



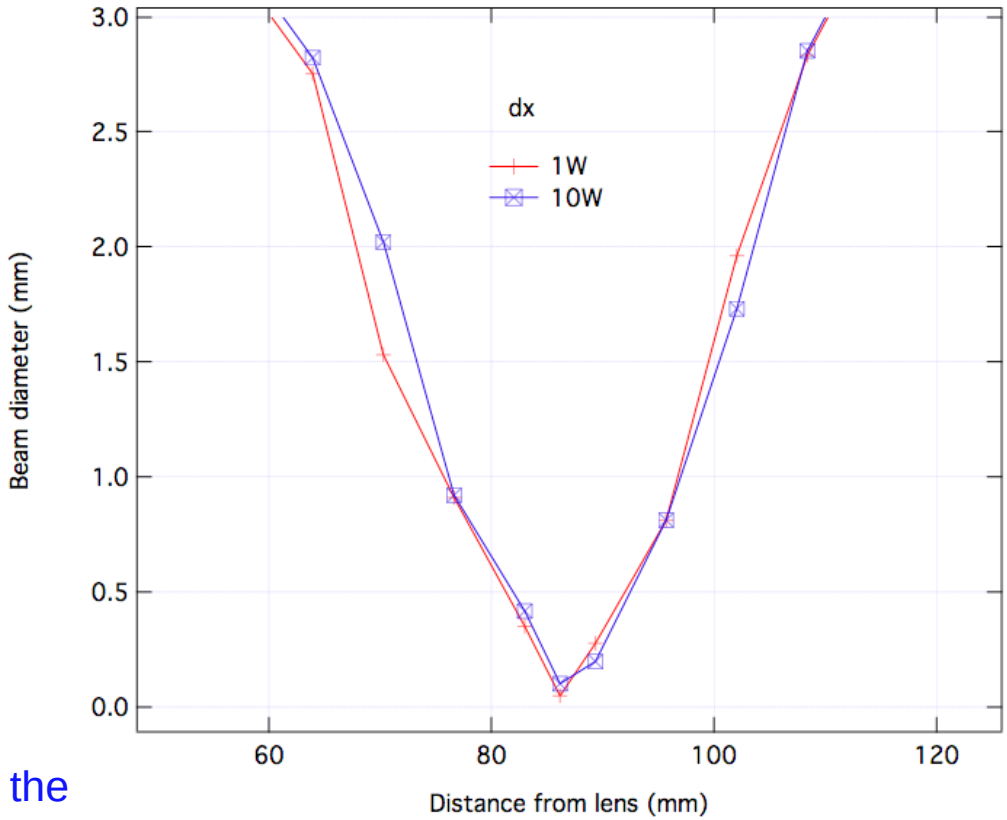
Experimental Setup - other views (2)

HWP2 for automated power control

Beam profile measurements (1)



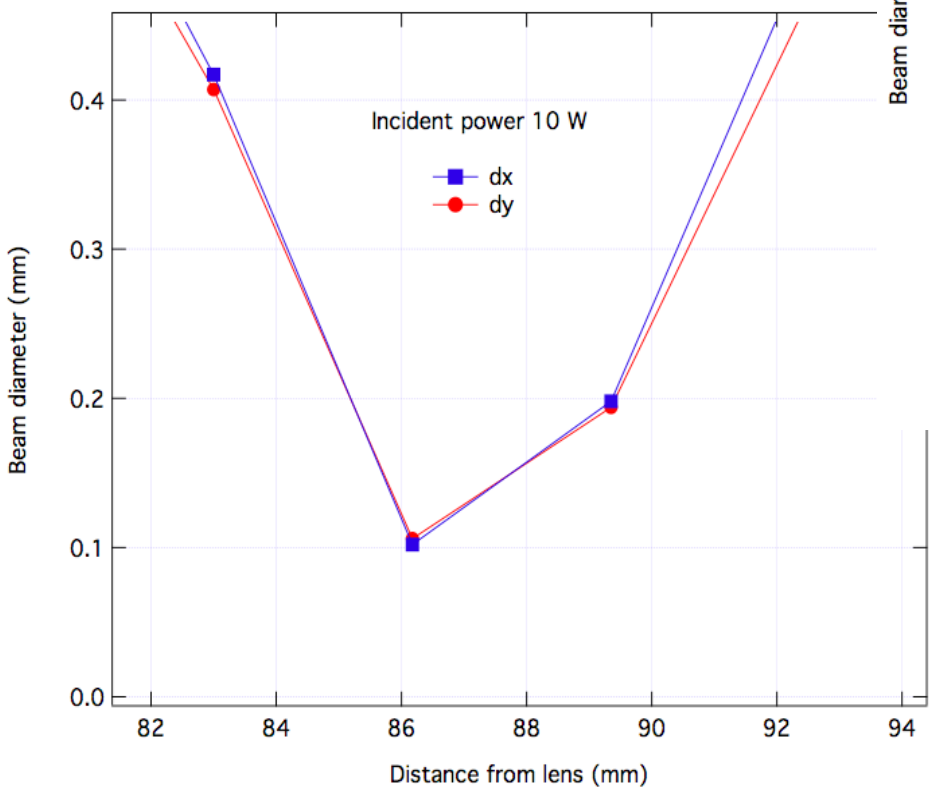
COMMENT:
Good data for y slit and close to focus for x slit, where the beam size was small enough to avoid the damaged spot on the beam scan

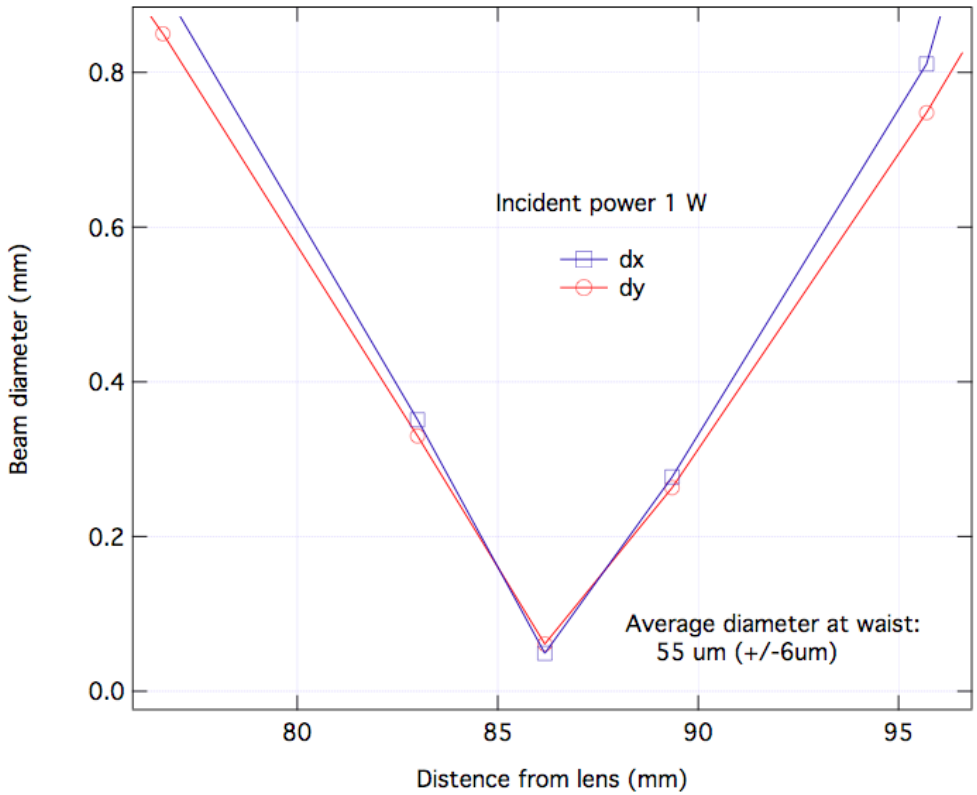


Problems with x slit of the beam scan

Beam profile measurements (2)

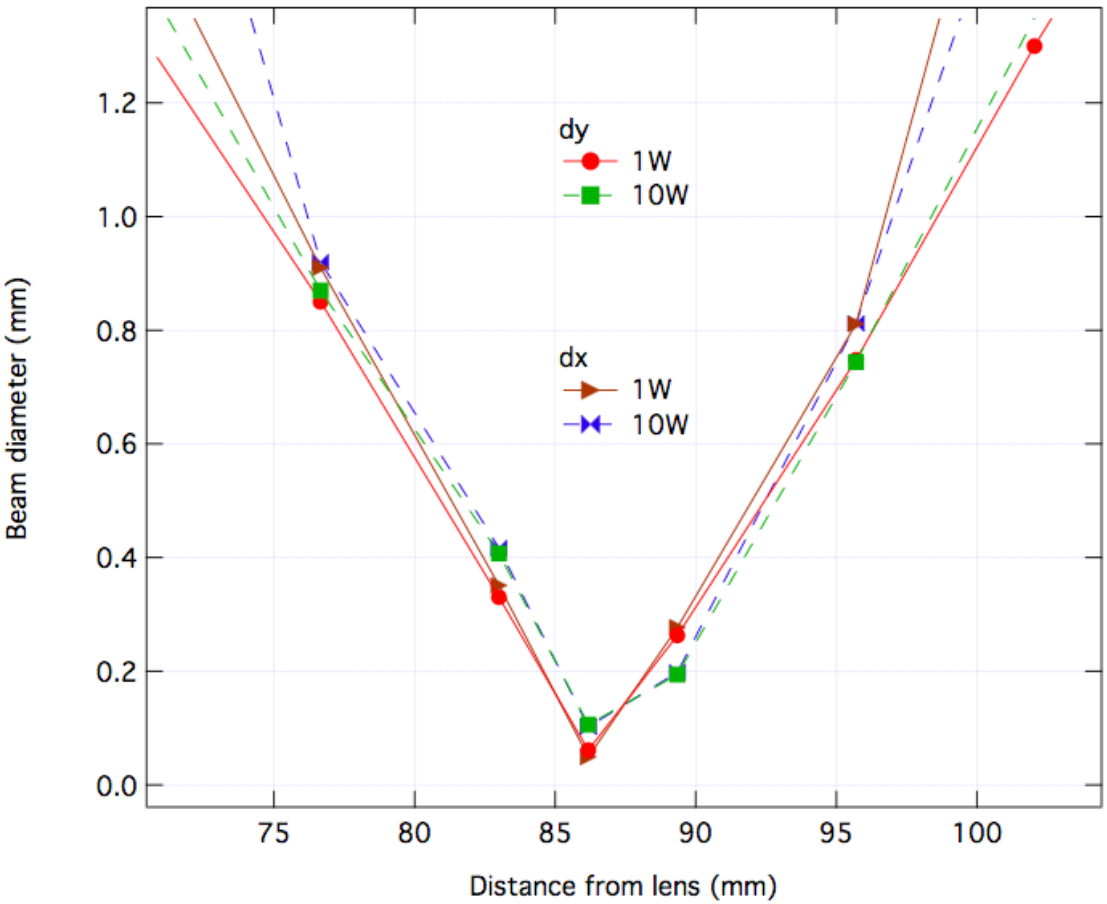
Expansion of the graphs at the focus





Beam profile measurements (3)

same data, all on one graph



- Weak thermal lensing observed
- At 10 W, a value close to 55 μm (as measured at 1 W) can also be estimated;
- Thermal lensing in the system/laser at 100W may make the spot size even smaller, but we cannot measure it. (Our beam scan failed at 50 W and 320 μm beam diameter!)

Max intensity at 55 μm is $I_{\max} = \dfrac{100\ \mathrm{W}}{\pi\left(\frac{55\cdot 10^{-4}\ \mathrm{cm}}{2}\right)^2} = 4.2\cdot 10^{6}\ \mathrm{W/cm^2} = 4.2\ \mathrm{MW/cm^2}$

Conclusions

- Using the IPG laser, we reach 4.2 MW/cm^2, high enough to test the LMA coating
- Experimental setup: ready, except for concerns about back reflection into the fiber laser
  - » Back reflection is a HUGE issue for fiber lasers
- Leakage through the CVI TFP:
  - » 0.75 W (p-pol) at max laser power (~100 W) with all light rejected (s-pol). This is too much!
- Solution:
  - » High power Faraday isolator (just designed for eLIGO)
    - – Use our prototype
    - – Use the one from initial LIGO H1
  - » Tilt beam to avoid reflecting back into the laser?
    - – Beam is too wide (required for a small spot on the test mirror)
    - – The lens transports the beam back parallel to its initial propagation, we need to separate it by at least 1 diameter, and dump it.
    - – DOES NOT WORK!

Done

Thanks