H2 TMS Y QPD Sled
- As Built -

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LIGO-T1100476

QPD Sled Telescopes

- The TMS/ISC Breadboard has two QPD sleds, one for IR and one for Green.
- Each sled, has a small Gouy phase beam reducing telescope to steer the beam onto the QPDs.
- The Gouy phase between the two QPDs needs to be close to 90 degrees (for a diagonal sensing matrix in the near- and far field).

Mode-Matching Approach

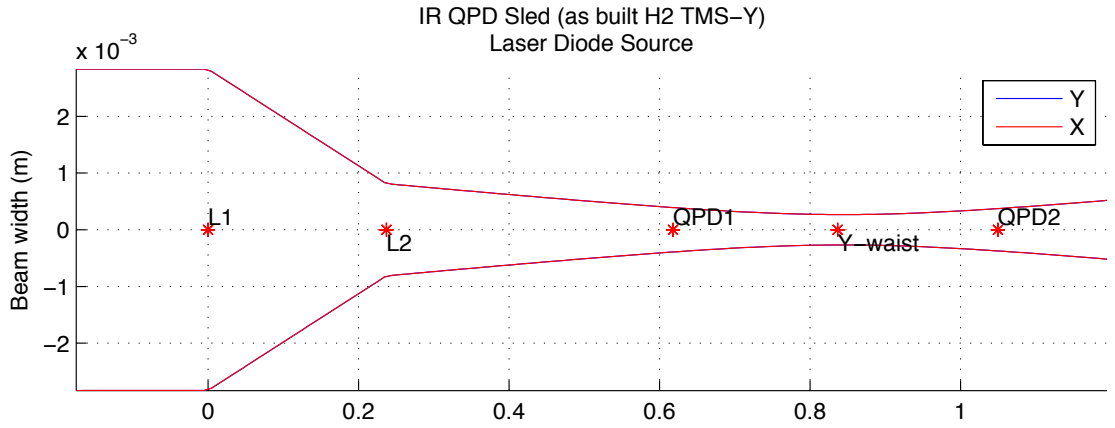
- The sleds are assembled, and the telescope optics (2” lens and a 1” lens) are placed as illustrated in figures 8 and 10 in document T1000247.
- The nominal location for L1 and L2 as listed in the tables 8 and 9 are used.
- For mode-matching measurements, the IR and GRN Laser Diode sources as per T1100474 are used.
- The Coherence ModeMaster is used to measure the waist location and size behind the telescope.
- The location of L2 is adjusted to match the measured waist location and size as close as possible according to T1000247.

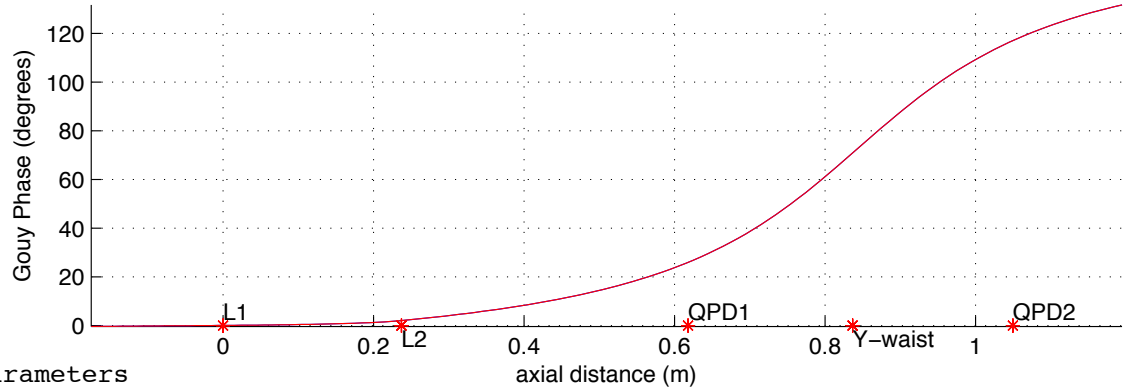
Mode-Matching Validation

- Once the telescopes are aligned, a matlab model (alm) is used to validate the location of the QPDs with respect to the measured waist locations.
- This is done by adjusting the model (changing the distance between L1 and L2) such that the waist location is similar to the measured results (using the LD sources as input to the telescope).
- With these telescope settings and ‘injected’ the IFO arm cavity beam parameters (e.g. out of the TMS Telescope), adjust the location of the QPDs so the difference in Gouy Phase is nominal 90 degrees.

IR QPD Sled /w LD Source

Adjusted the L2 location in the model until the output waist coincided with the measured waist location (Y-waist).



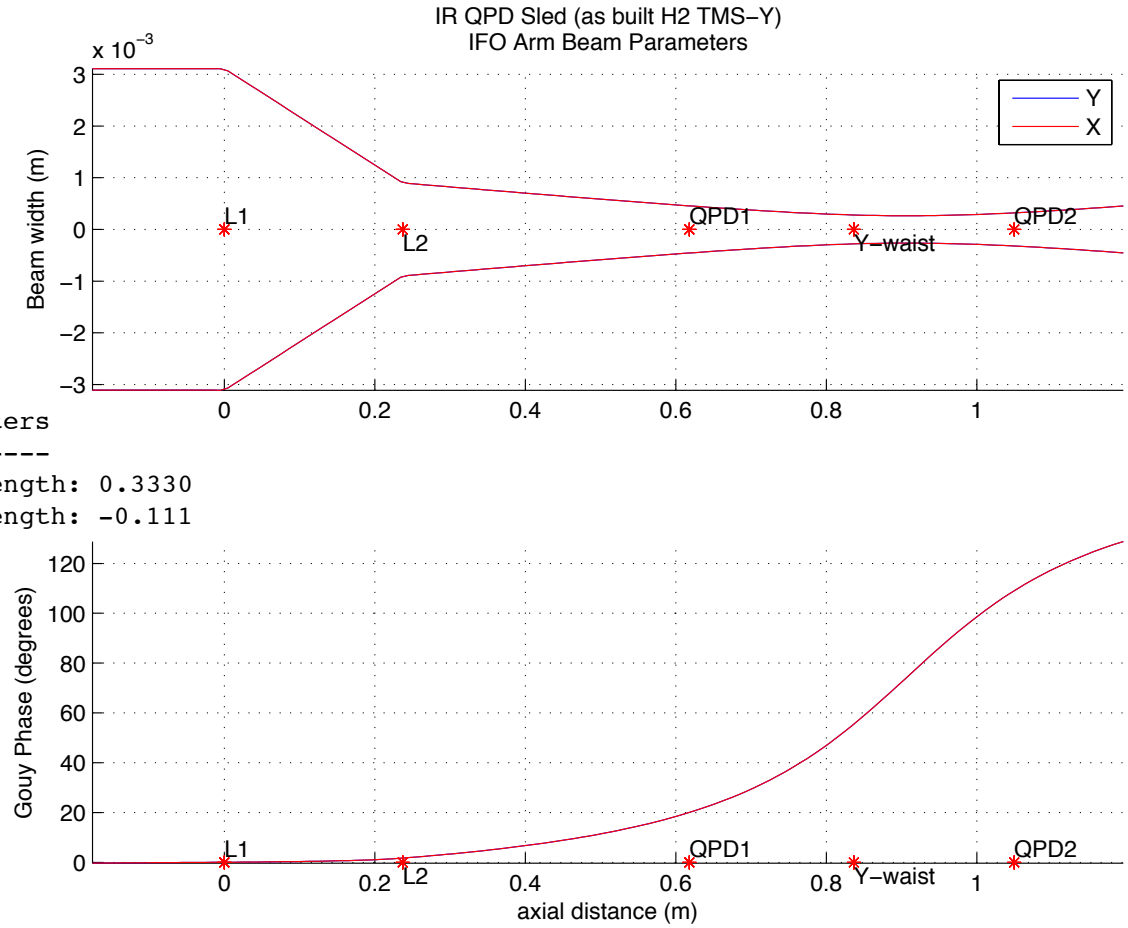



```
Waist location target: 0.80m
(as per T1000247, table 8, fig 7)

Laser Diode Source
modematching = 0.99412
IRxpath.components list

Measured Parameters:
(* = adjusted z(m) parameter)

    label      z (m)      type           parameters
    -----      -----      ----           ----------
    L1             0      lens           focalLength: 0.3330
*   L2        0.2370      lens           focalLength: -0.111
    QPD1      0.6180      flat mirror    none:
    Y-waist   0.8366      flat mirror    none:
    QPD2      1.0498      flat mirror    none:
```

IR QPD Sled /w IFO Beam (as-built)

Using the model to locate the QPDs.

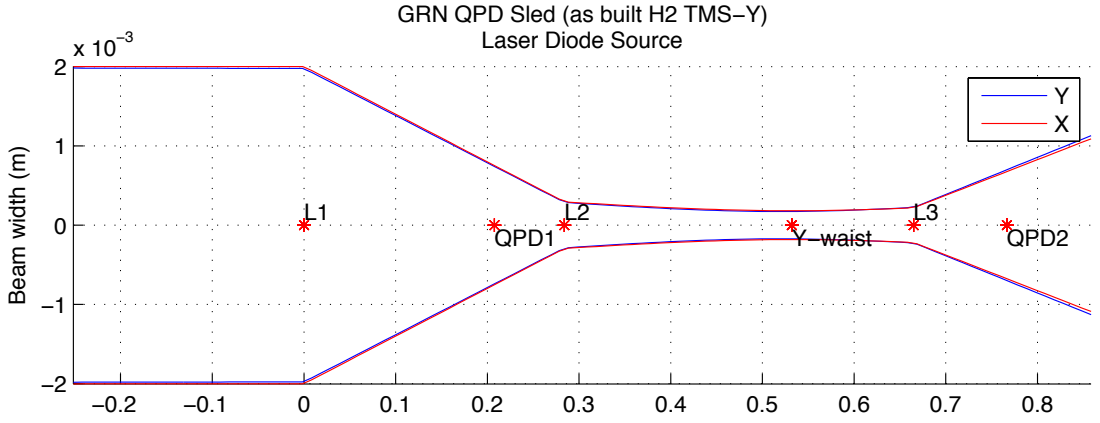
```
IFO Arm Beam Parameters
modematching = 0.96367
IRxpath.components list

Modeled Parameters:
(* = adjusted z(m) parameter)

 label      z (m)     type           parameters
 -----      -----     ----           ----------
 L1             0     lens           focalLength: 0.3330
 L2        0.2370     lens           focalLength: -0.111
*QPD1      ***0.6180***  flat mirror    none:
 Y-waist    0.8366    flat mirror    none:
*QPD2      ***1.0498***  flat mirror    none:
```

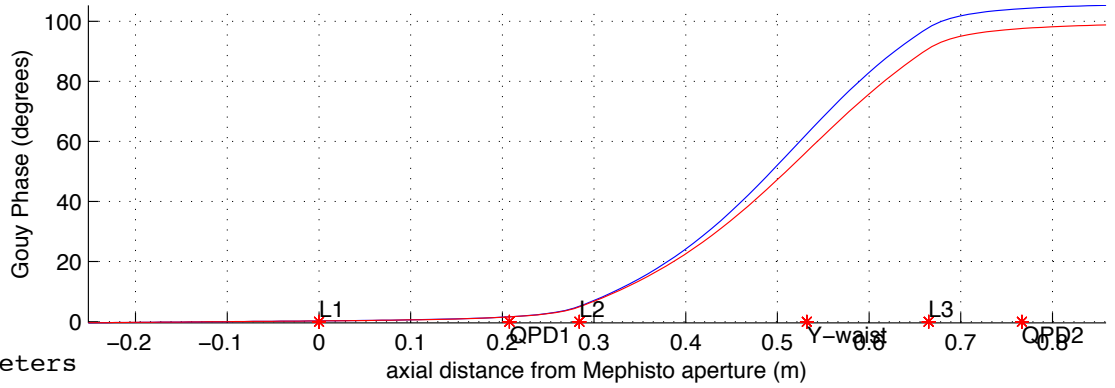



```
Gouy Phase-x (QPD1): 20.0427
Gouy Phase-y (QPD1): 20.0427
Gouy Phase-x (QPD2): 109.0697
Gouy Phase-y (QPD2): 109.0697
```

GRN QPD Sled /w LD Source

Adjusted the L2 location in the model until the output waist coincided with the measured waist location (Y-waist).






```
Waist location target: 0.619m
(as per T1000247, table 9, fig 9)

Laser Diode Source
modematching = 0.94505
GRNxpath.components list

Measured Parameters:
(* = adjusted z(m) parameter)

    label       z (m)      type           parameters
    -----       -----      ----           ----------
    L1              0      lens           focalLength: 0.3330
    QPD1       0.2078      flat mirror    none:
 *  L2         0.2840      lens           focalLength: -0.056
    Y-waist    0.5320      flat mirror    none:
    L3         0.6650      lens           focalLength: -0.056
    QPD2       0.7666      flat mirror    none:
```

GRN QPD Sled /w IFO Beam (as-built)

Using the model to locate the QPDs.

```
IFO Arm Beam Parameters
modematching = 0.95444
GRNxpath.components list

Modeled Parameters:
(* = adjusted z(m) parameter)

 label      z (m)     type           parameters
 -----      -----     ----           ----------
 L1             0     lens           focalLength: 0.3330
*QPD1       0.1824     flat mirror    none:
 L2         0.2840     lens           focalLength: -0.056
 Y-waist    0.5320     flat mirror    none:
*L3         0.6650     lens           focalLength: -0.056
*QPD2       0.9190     flat mirror    none:
```

```
Gouy Phase-x (QPD1): 1.0042
Gouy Phase-y (QPD1): 1.0042
Gouy Phase-x (QPD2): 92.9226
Gouy Phase-y (QPD2): 92.9226
```