AS Port Wavefront Sensing SRM/BS Signals

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What's the Issue?

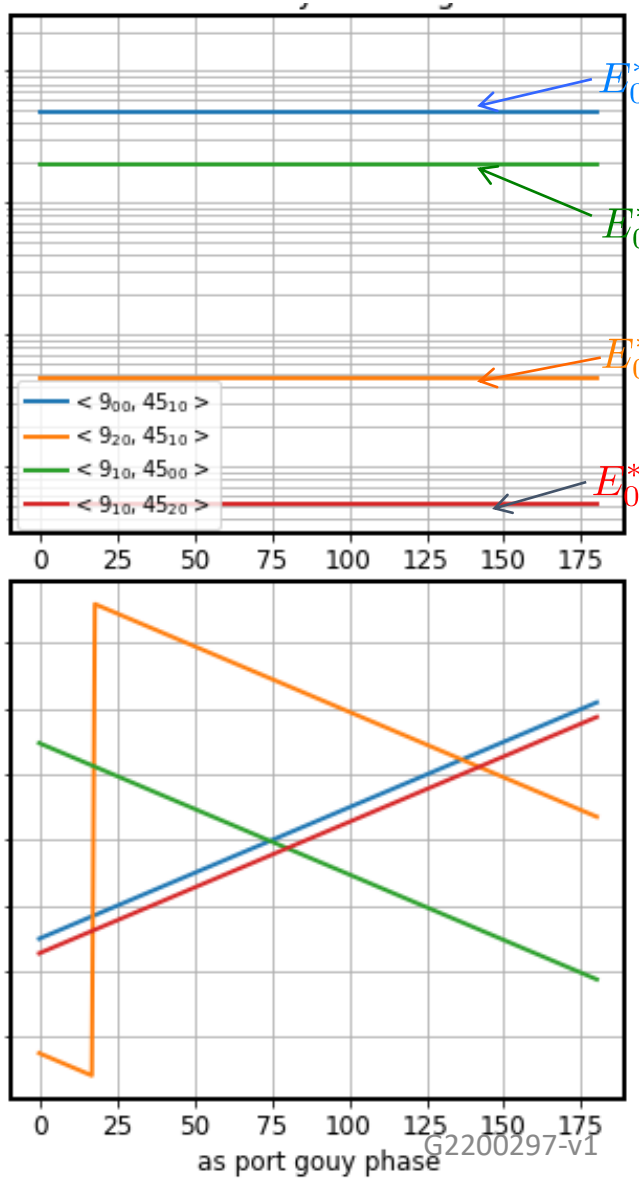
- WFS36 at the AS port is not a good wavefront sensor
  - Signal for SRM is basically an RF optical lever
  - SRM signal changes significantly with thermal heating/ifo power
  - Signal is dominated by BS (different RF phase but still very large)
- ~~First idea: centering is affected by carrier junk light~~
- Second idea: 9MHz RF sidebands are very small and susceptible to thermal heating
  - Near dark fringe and non resonant in SRM
  - 45 MHz RF sidebands are "stabilized" by SRM because they are resonant

Different fields' contribution

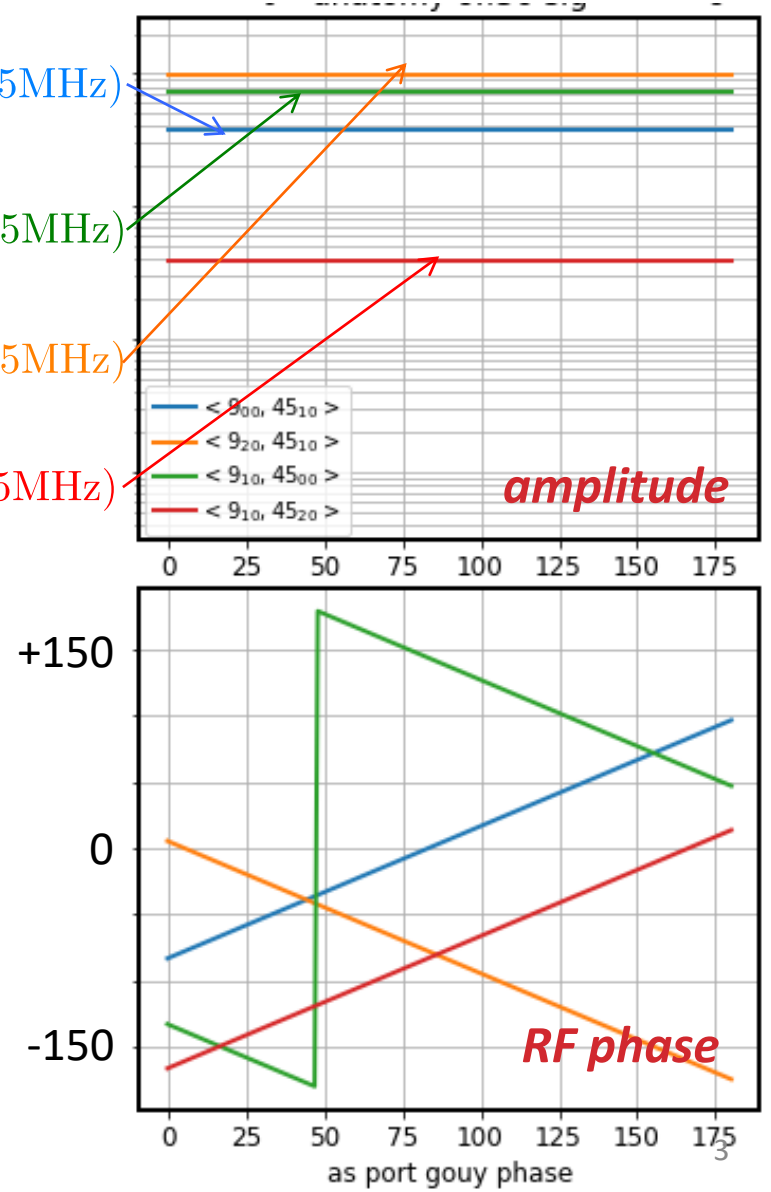
ITM lensing generates large signals contributing to the 36MHz beat

Point absorbers will generate additional HOM contributions

Nominal



Extra 100 km ITMX lens

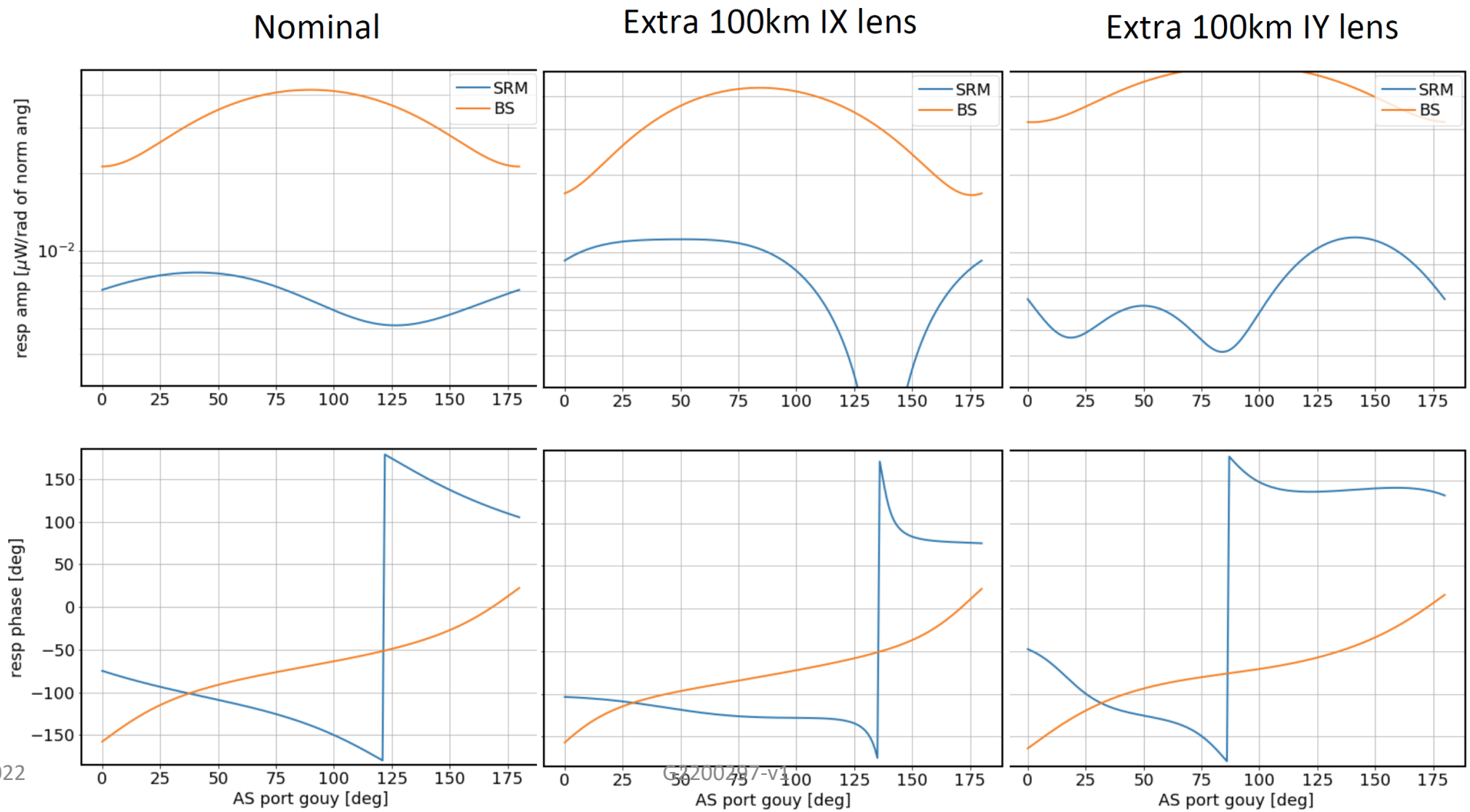


Solution

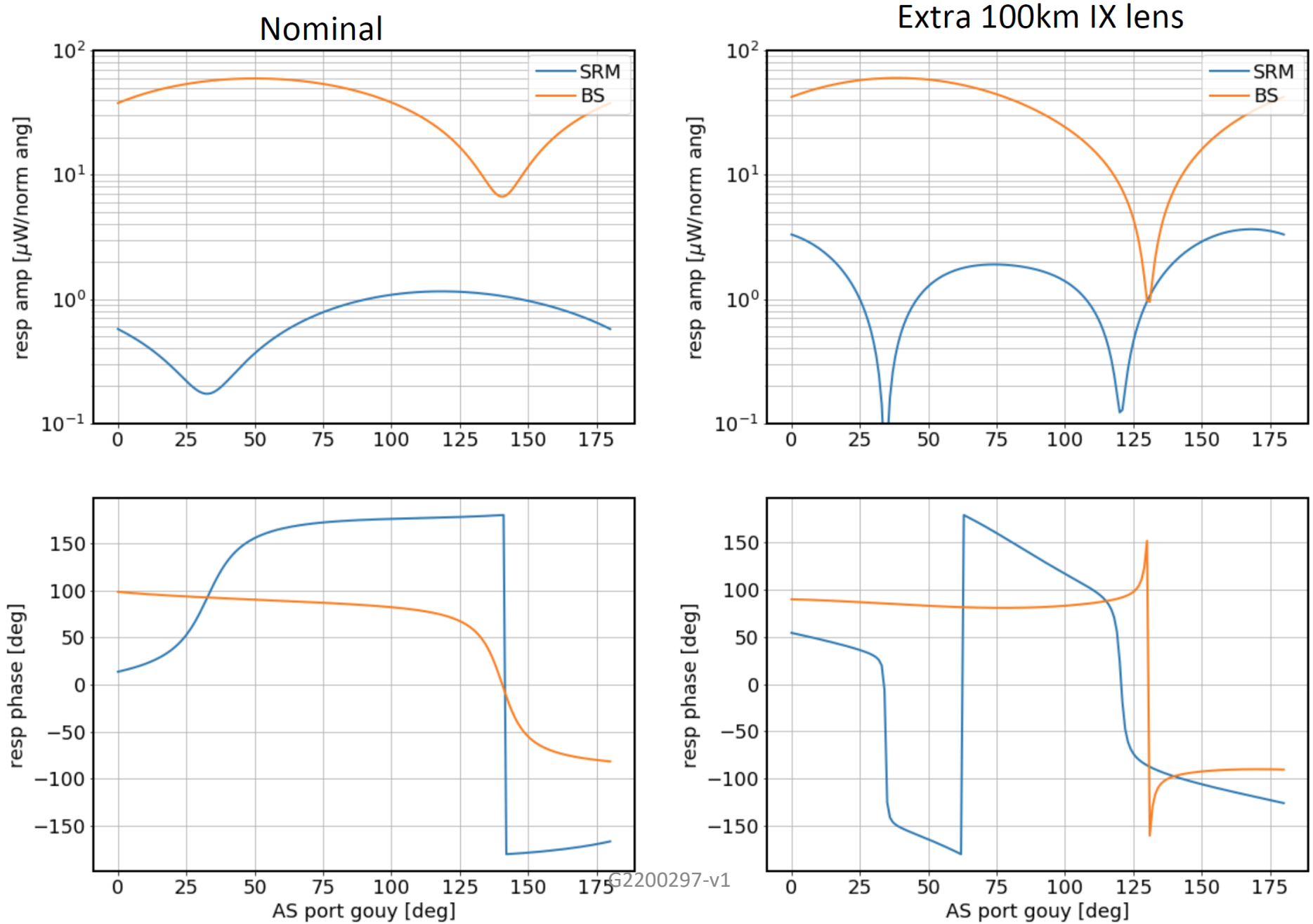
- Pick a higher frequency RF sideband
  - Further away from the dark fringe
  - More power transferred to the AS port
  - Less susceptible to heating (because there is more TEM00)
- We chose 13^{th} harmonics at 117 MHz (more like 118.3 MHz)
- Demodulate between 5^{th} and 13^{th}: 8^{th} order at 72 MHz
- Make sure SRC gouy phase is at least 20°.

AS72

(T_srm=0.32;
SRC one-way gouy 22 deg)



AS36


Nominal
Extra 100km IX lens
SRM
BS
resp amp [μW/norm ang]
resp phase [deg]
AS port gouy [deg]

References:

- **T1700215-v3: Alignment sensing in the signal recycling cavity using a new 118.3 MHz sideband scheme**
  https://dcc.ligo.org/LIGO-T1700215
- **T1700324-v2: Implementing the 118 MHz wave front sensors**
  https://dcc.ligo.org/LIGO-T1700324
- **G1700603-v5: Differential Lensing vs. SRM Sensing**
  https://dcc.ligo.org/LIGO-G1700603
- **G1800719-v1: AS72 for SRM/BS alignment sensing**
  https://dcc.ligo.org/LIGO-G1800719