Source Interference at Millimeter Wavelengths from Dipole Ring Chamber

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Beamline(s): **U12IR**

Introduction: The spectral intensity in the very far infrared (millimeter wavelengths) exhibits strong interference oscillations ("fringes", see **Figure 1**). The fringe period is approximately 1 cm^{-1}, with the first maximum near 0.5 cm^{-1}. A candidate mechanism for this fringing is light reflected from the outer curved wall of the ring vacuum chamber, located inside one of the dipole magnets (see **Figure 2**). Light produced at the upstream point (A) is delayed by 1 cm and shifted in phase by 180 degrees (due to reflection) before merging with light produced at point (B). The light from these two source points interferes to produces the fringes. Fringe contrast (amplitude) is greatest at long wavelengths where the apparent source size is comparable to the chamber cross-section dimensions.

Results: To test this hypothesis, we measured the infrared fringe period while varying the horizontal beam position. The calculated experimentally measured period are shown in **Figure 3**. Agreement is very good.

Conclusions: Light reflected from the chamber wall leads to interference and large oscillations in the spectral intensity at long wavelengths. The fringe pattern is sensitive to horizontal beam position.

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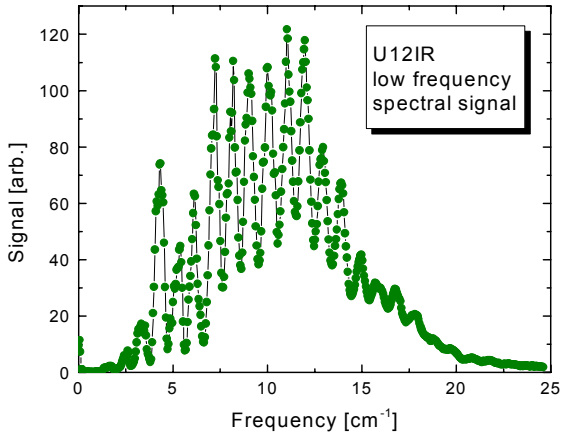

Figure 1. Spectral signal (intensity) for beamline U12IR.

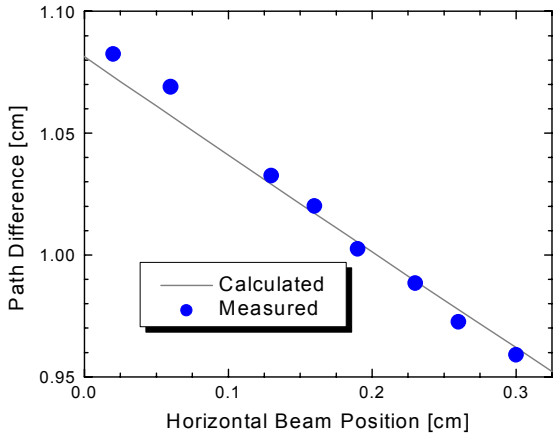

Figure 3. Beam path difference (or delay) for light reflected from the ring chamber outer wall as a function of horizontal beam position. Both calculated (solid line) and experimental results (blue circles) are shown.

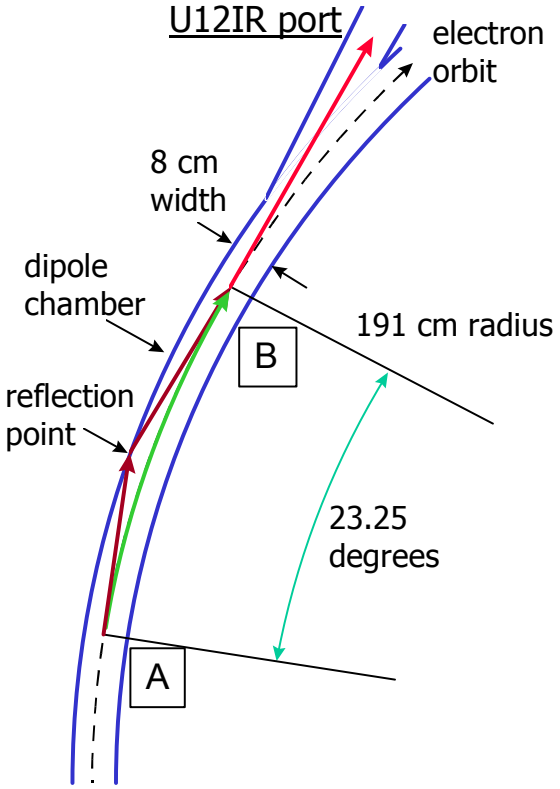

Figure 2. Reflection geometry schematic: Light produced near point A reflects from chamber wall and merges with light produced at point B.