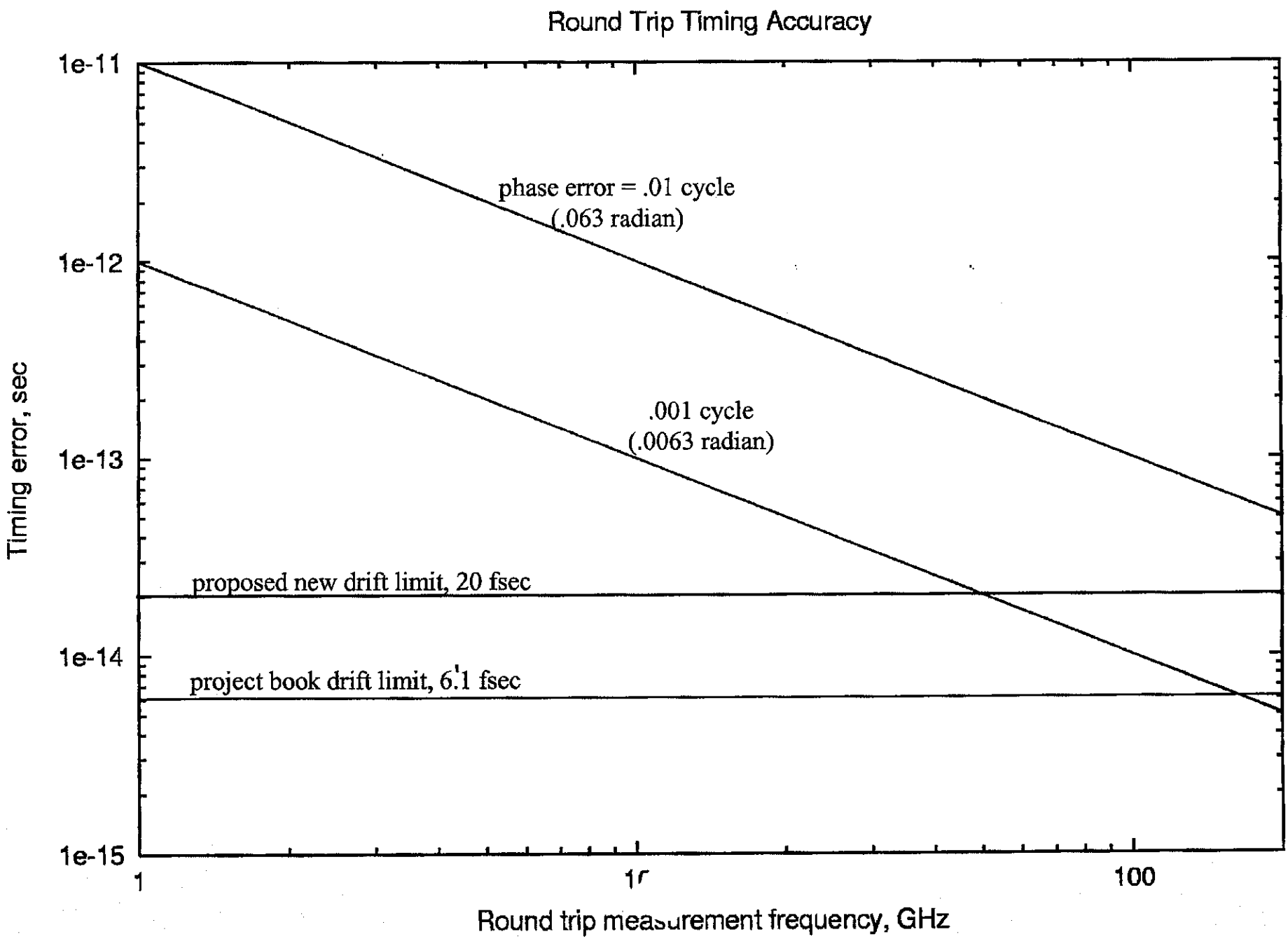
Round Trip Timing vs. Phase Detection Accuracy



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Phase Accuracy Limit

Round trip correction accuracy is limited by

- Thermal and shot noise
  - SNR = 60 dB for rms phase error of .001 radian
- Phase detector errors
  - Leakage between signal and reference inputs of phase detector

    Often the signal is 30 dB below the reference, so –90dB leakage produces –60 dB error.
  - Low level spurious signals (-60 dBc for .001 radian)
  - d.c. drift at phase detector inputs or output
  - Amplitude changes produce apparent phase changes

The net result is that accuracy better than .001 radian (.06 degree) is nearly impossible to achieve, regardless of SNR. Accuracy better than .01 radian (0.6 degree) is very difficult in all but the simplest system.

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Principles for Setting Instrumental Specifications

- Set instrumental limit equal to 5th percentile atmospheric effect at 60 deg elevation
  - so we are limited by the atmosphere at least 95% of the time
  - more if we spend most time below 60 deg elevation
- Overall limits are then [preliminary values – illustrative only]
  - fast fluctuations (<20 sec) 91 fsec
  - drift (to 1000 sec) 43 fsec
- Allocate squared error limits to

		fast	*drift*
– structure	25%	45.5 fsec	21.5 fsec
– first LO	50%	64.3	30.4
• allocation to line length correction			20.0
– second and third LOs	5%	20.3	9.6
– signal path	20%	40.7	19.2

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Effect of the Atmosphere at the 5th Percentile

- Coherence
  - Zenith delay fluctuation at 300m baseline 160 fsec
  - After correction by fast switching 85 fsec
  - At 60 degrees elevation 91 fsec
  - Corresponding coherence at 875 GHz 0.78
- Accuracy --- Mark Holdaway's simulation optimized at 850 GHz, preliminary results – subject to revision, presented here for illustration only
  - Target cycle residual error, each cycle (19.8 sec) 72 fsec
  - Residual error after 300 sec, target cycle 20 fsec
  - Instrumental cycle residual error 36 fsec
  - Net error in final visibility phase 41 fsec
  - Corresponding phase error at 875 GHz 13 deg

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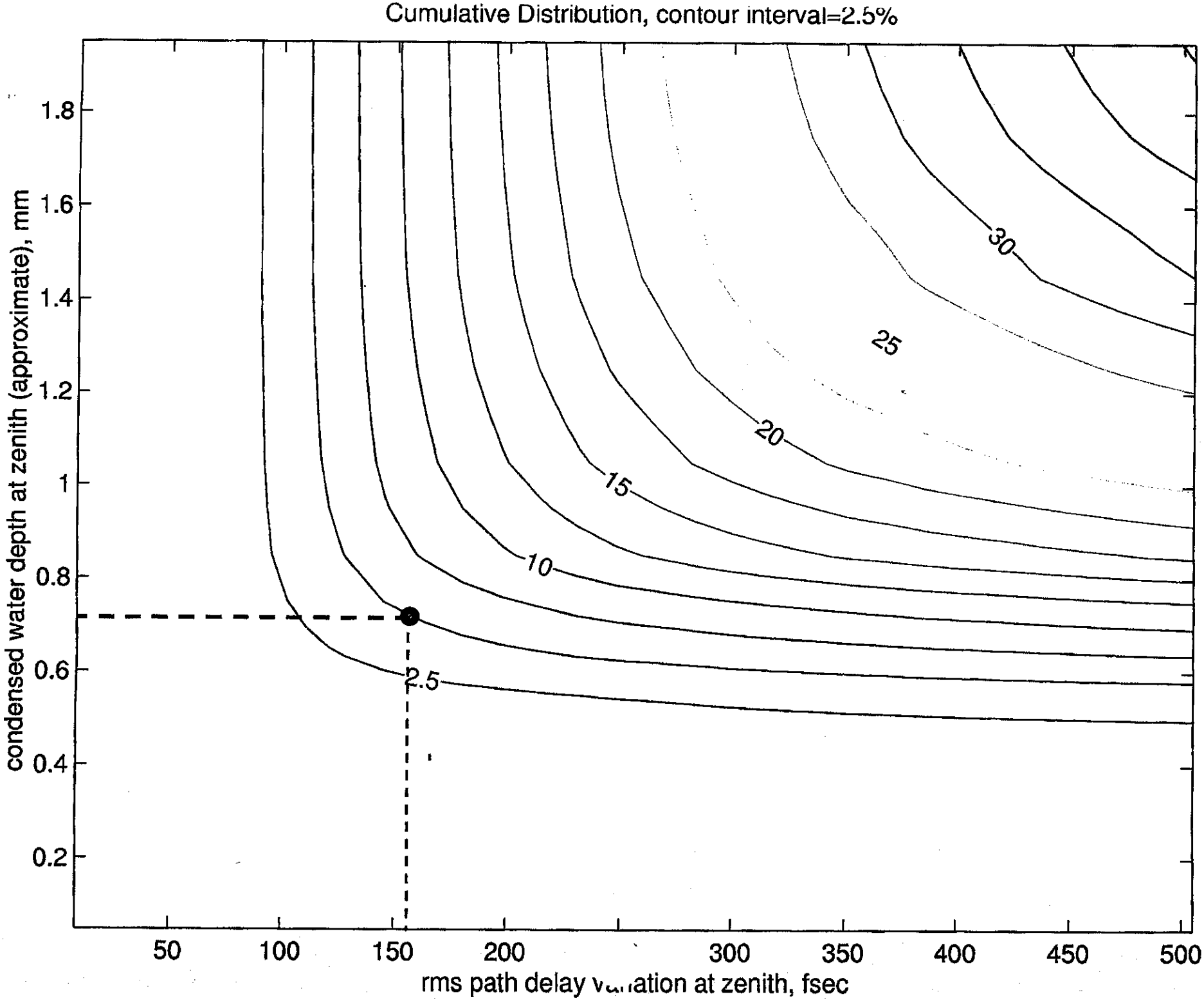

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