Coaxial Cable Delay Measurements
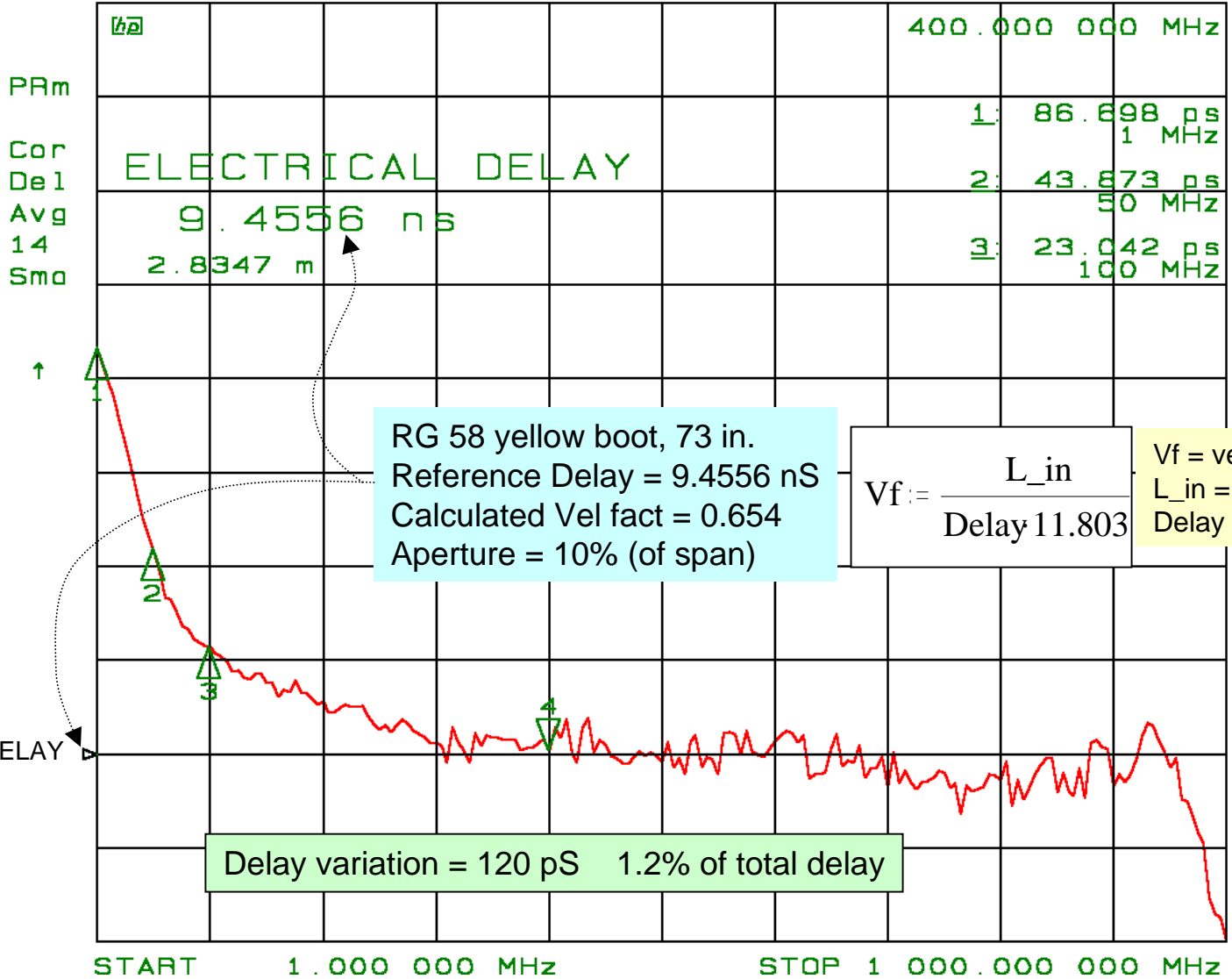
Using the HP 8753D VNA

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CH1 S$_{21}$ delay   20 ps/   REF 0 s

4: 935.69 fs

400.000 000 MHz

PRm

1: 86.698 ps
1 MHz

Cor
Del

ELECTRICAL DELAY

2: 43.873 ps
50 MHz

Avg
14
Smo

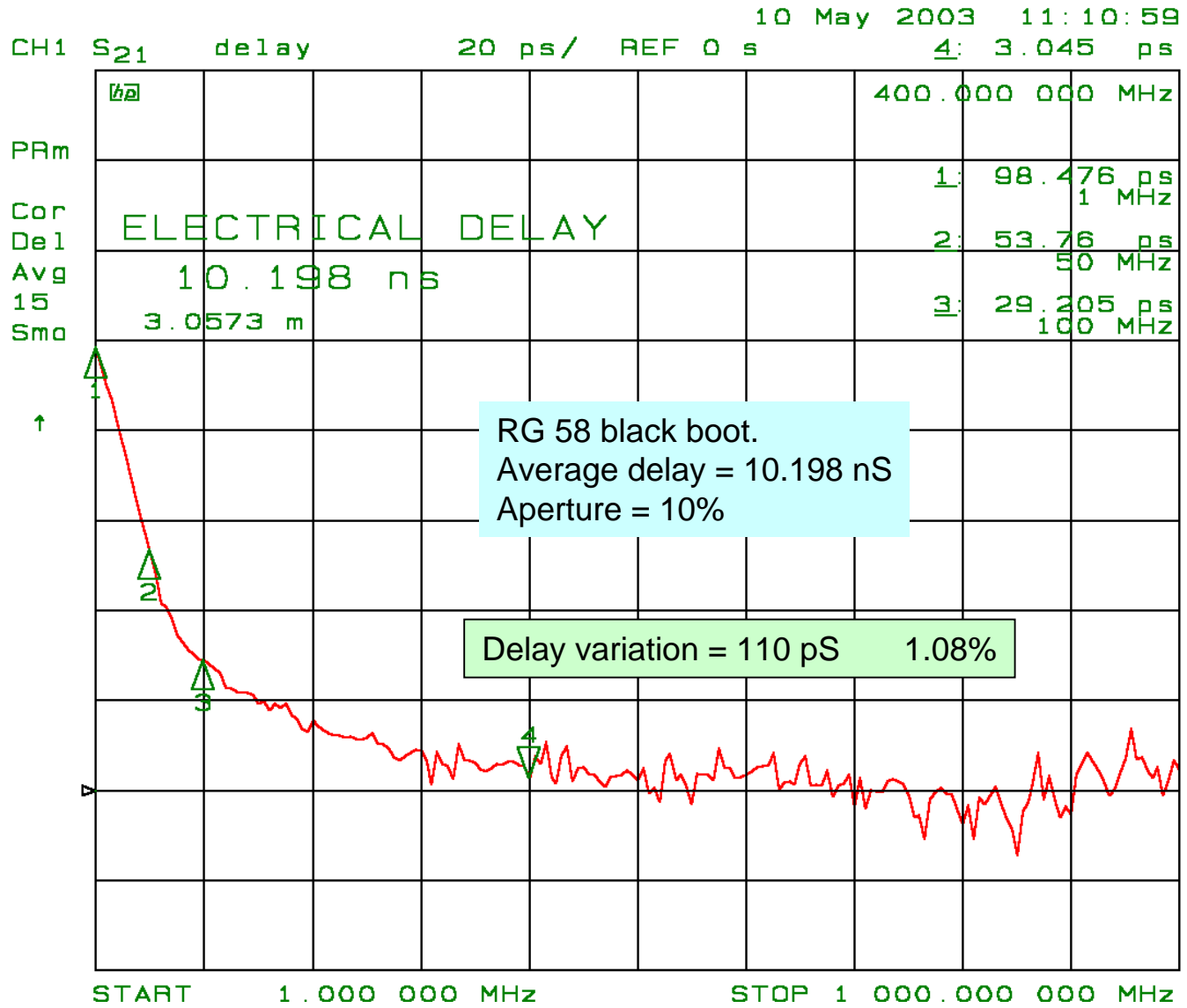9.4556 nS

2.8347 m

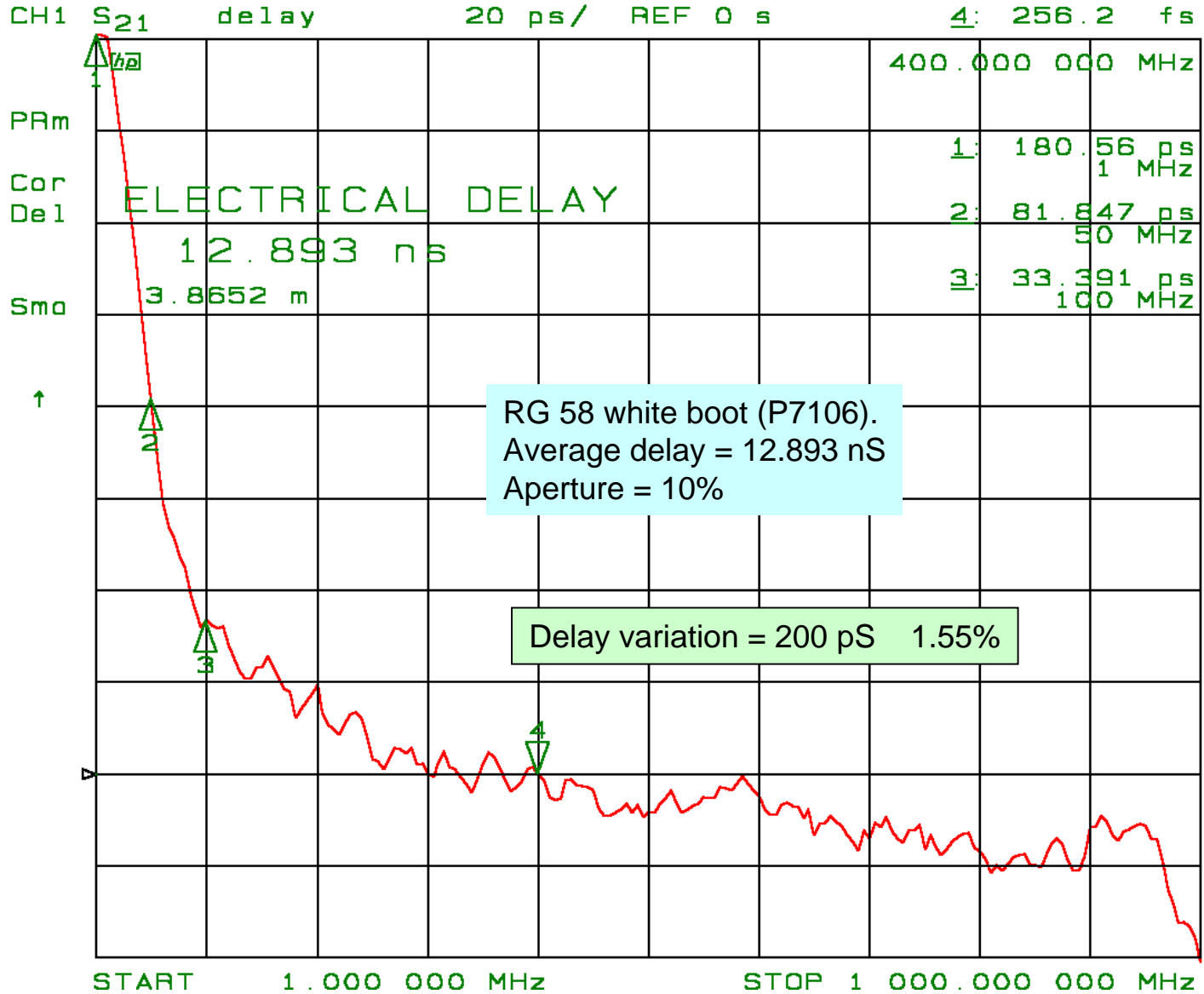3: 23.042 ps
100 MHz

Delays are
relative to
REF DELAY

↑

RG 58 yellow boot, 73 in.
Reference Delay = 9.4556 nS
Calculated Vel fact = 0.654
Aperture = 10% (of span)

$$Vf := \frac{L\_in}{Delay \cdot 11.803}$$

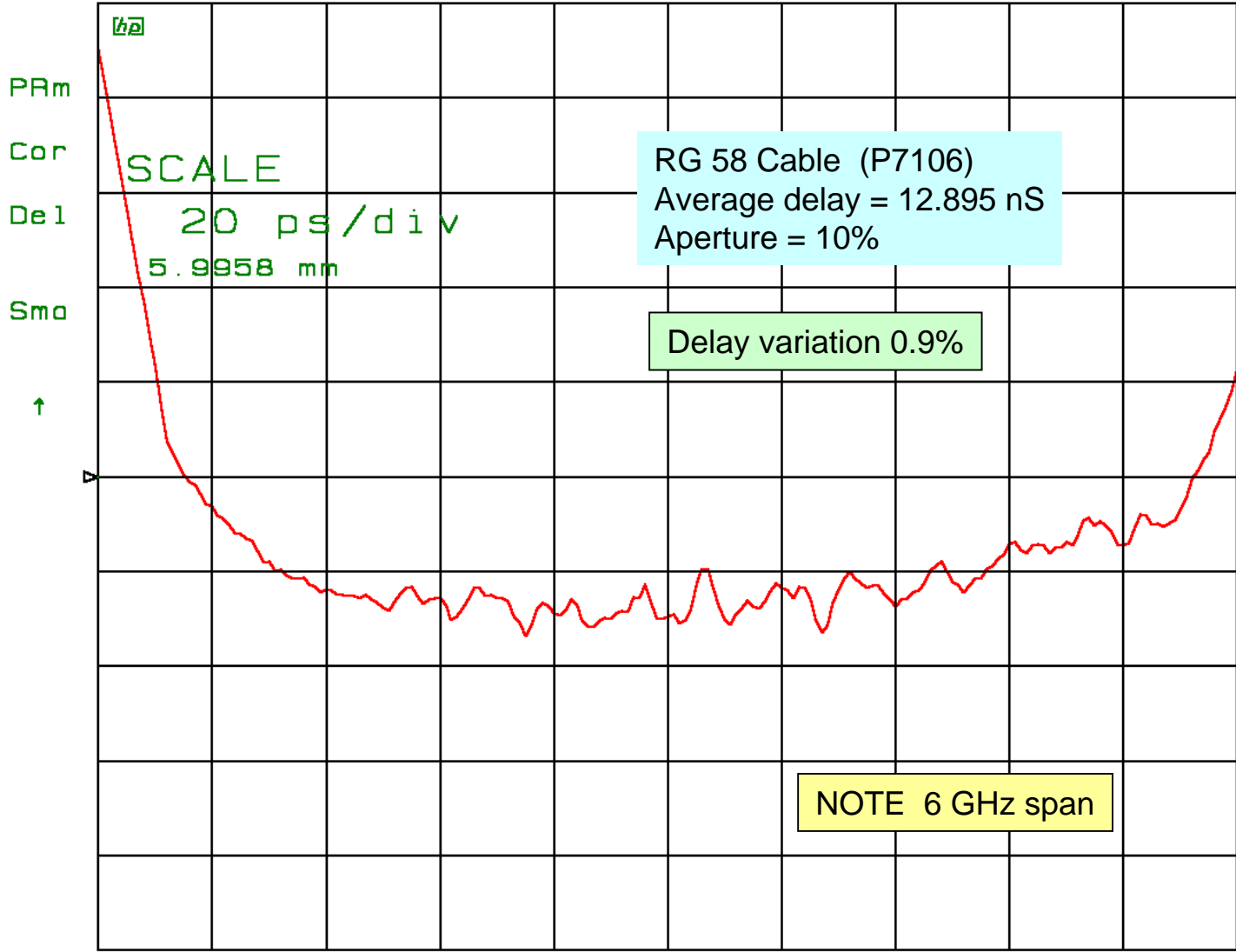Vf = velocity factor
L_in = length in in.
Delay in nSec

REF DELAY ▷

Delay variation = 120 pS   1.2% of total delay

START   1.000 000 MHz   STOP 1 000.000 000 MHz

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CH1 S21   delay   20 ps/   REF 0 s   4: 256.2   fs

10 May 2003   11:08:45

400.000 000 MHz

PRm

Cor
Del

ELECTRICAL DELAY

12.893 ns

3.8652 m

Smo

1:   180.56 ps
          1 MHz

2:   81.847 ps
         50 MHz

3:   33.391 ps
        100 MHz

RG 58 white boot (P7106).
Average delay = 12.893 nS
Aperture = 10%

Delay variation = 200 pS   1.55%

START   1.000 000 MHz   STOP 1 000.000 000 MHz

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CH1 S_{21}   delay   20 ps/   REF 0 s

23 Sep 2003   11:46:29

PRm

Cor   SCALE

Del   20 ps/div
          5.9958 mm

Smo

RG 58 Cable (P7106)
Average delay = 12.895 nS
Aperture = 10%

Delay variation 0.9%

NOTE 6 GHz span

START   .100 000 MHz   STOP 6 000.000 000 MHz
100 KHz

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CH1 S$_{21}$ delay   10 ps/   REF 0 s   10 May 2003   10:12:21
                                                    4: 3.1717 ps

400.000 000 MHz

PRm

Cor
Del   ELECTRICAL DELAY   1: 20.21 ps
                                                      1 MHz
Avg
16   3.7731 ns   2: 16.49 ps
Smo   50 MHz
          1.1311 m   3: 12.197 ps
                                                      100 MHz

HI Quality HP SMA Cable (violet pale)
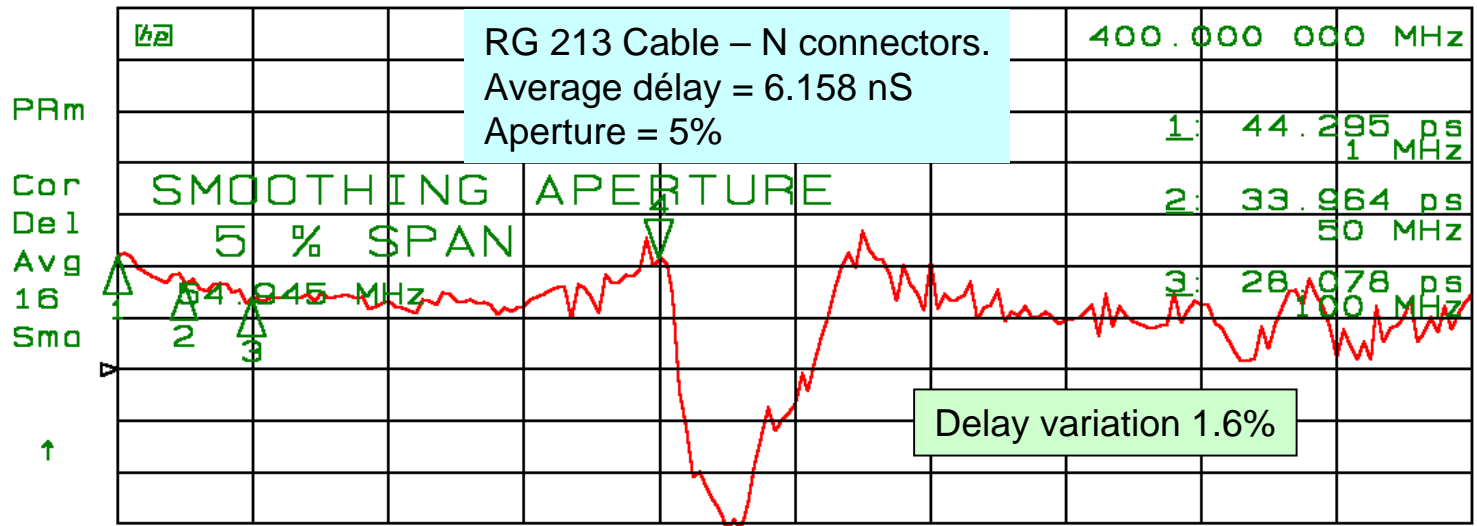for 10 GB/s data.
Average delay = 3.773 nS
Aperture = 20%
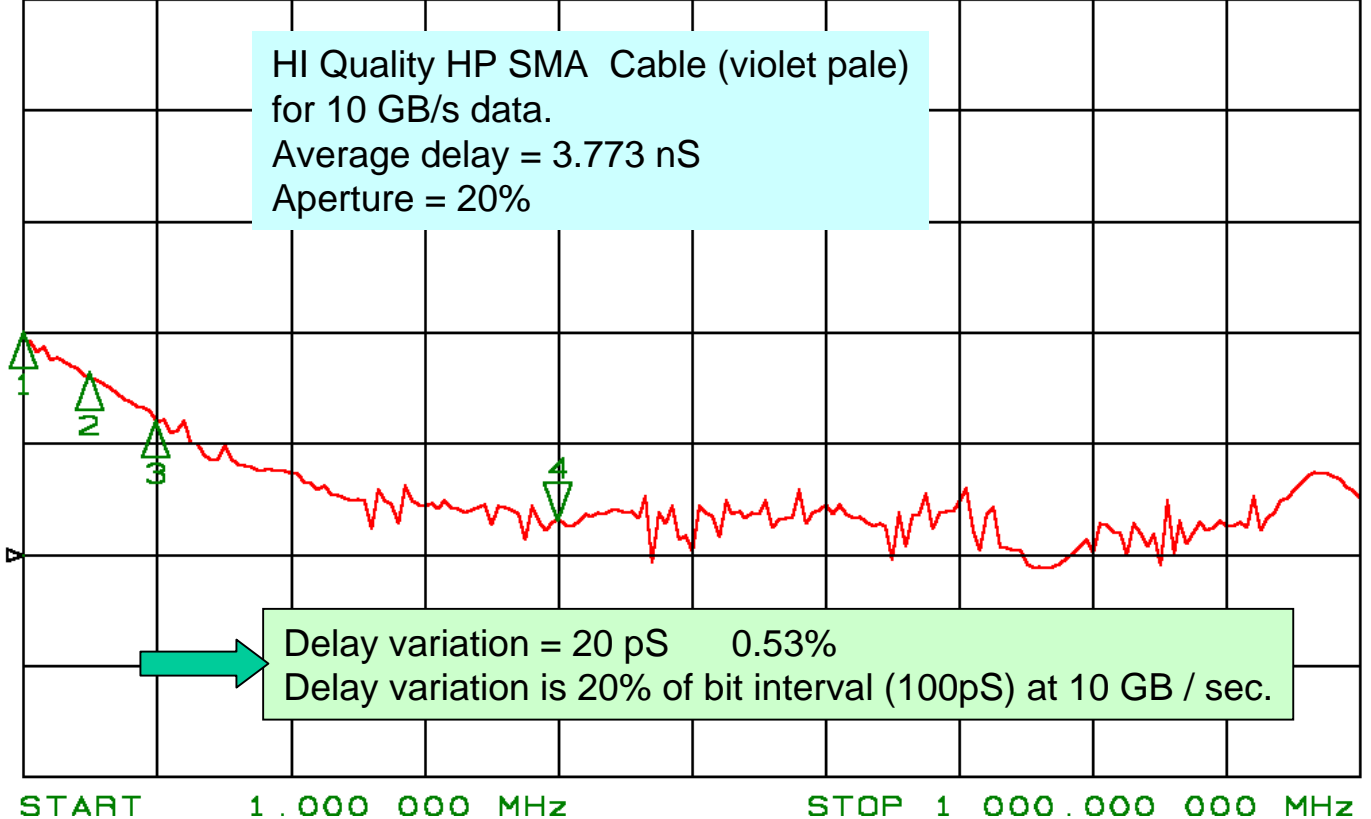
Delay variation = 20 pS   0.53%
Delay variation is 20% of bit interval (100pS) at 10 GB / sec.

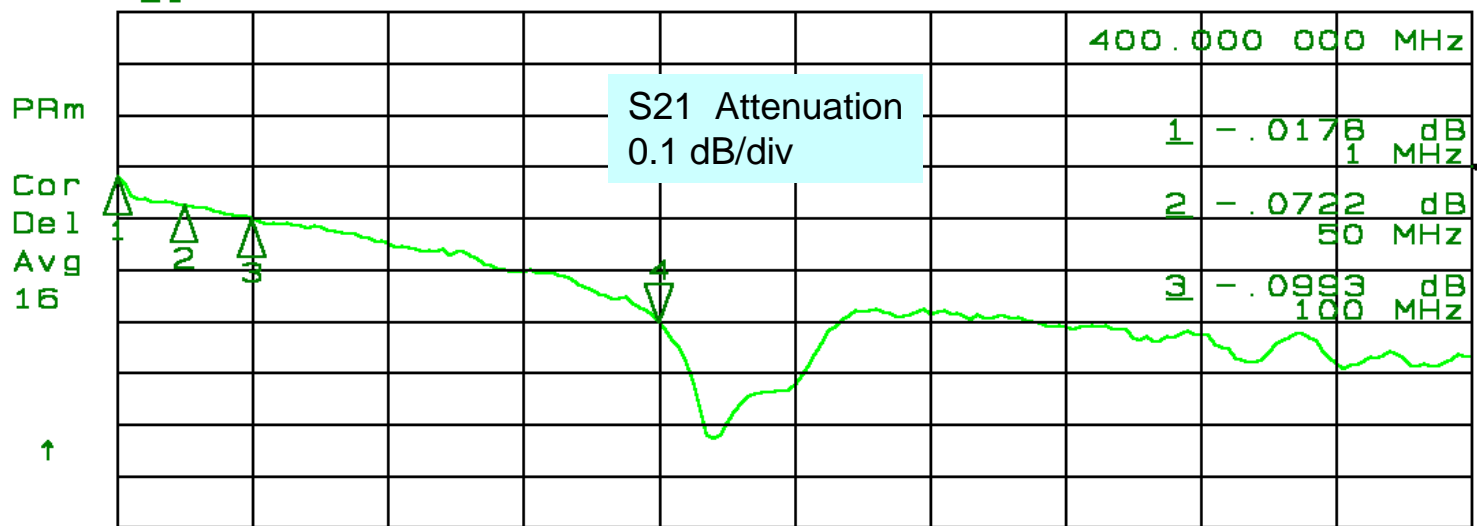START   1.000 000 MHz   STOP 1 000.000 000 MHz
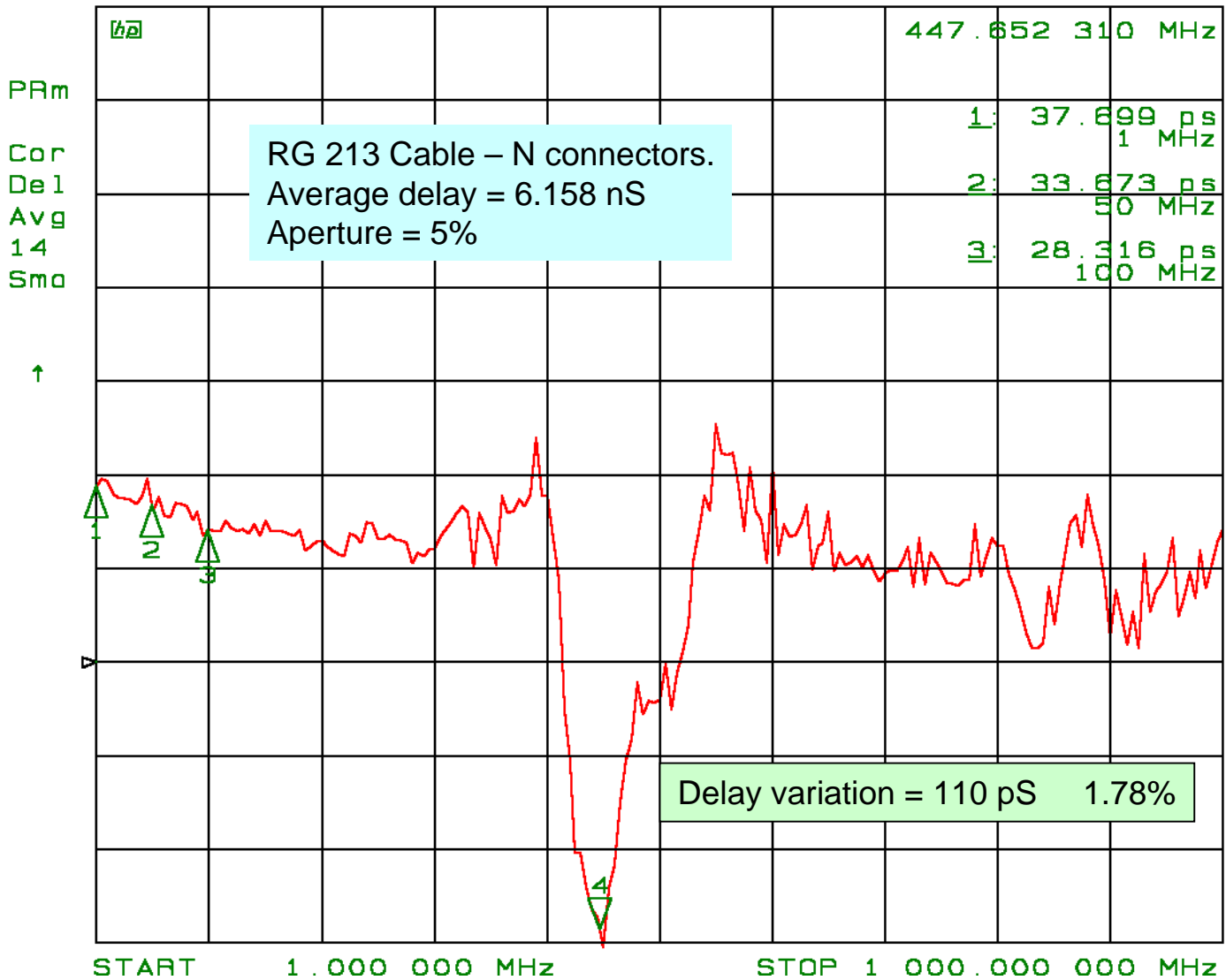
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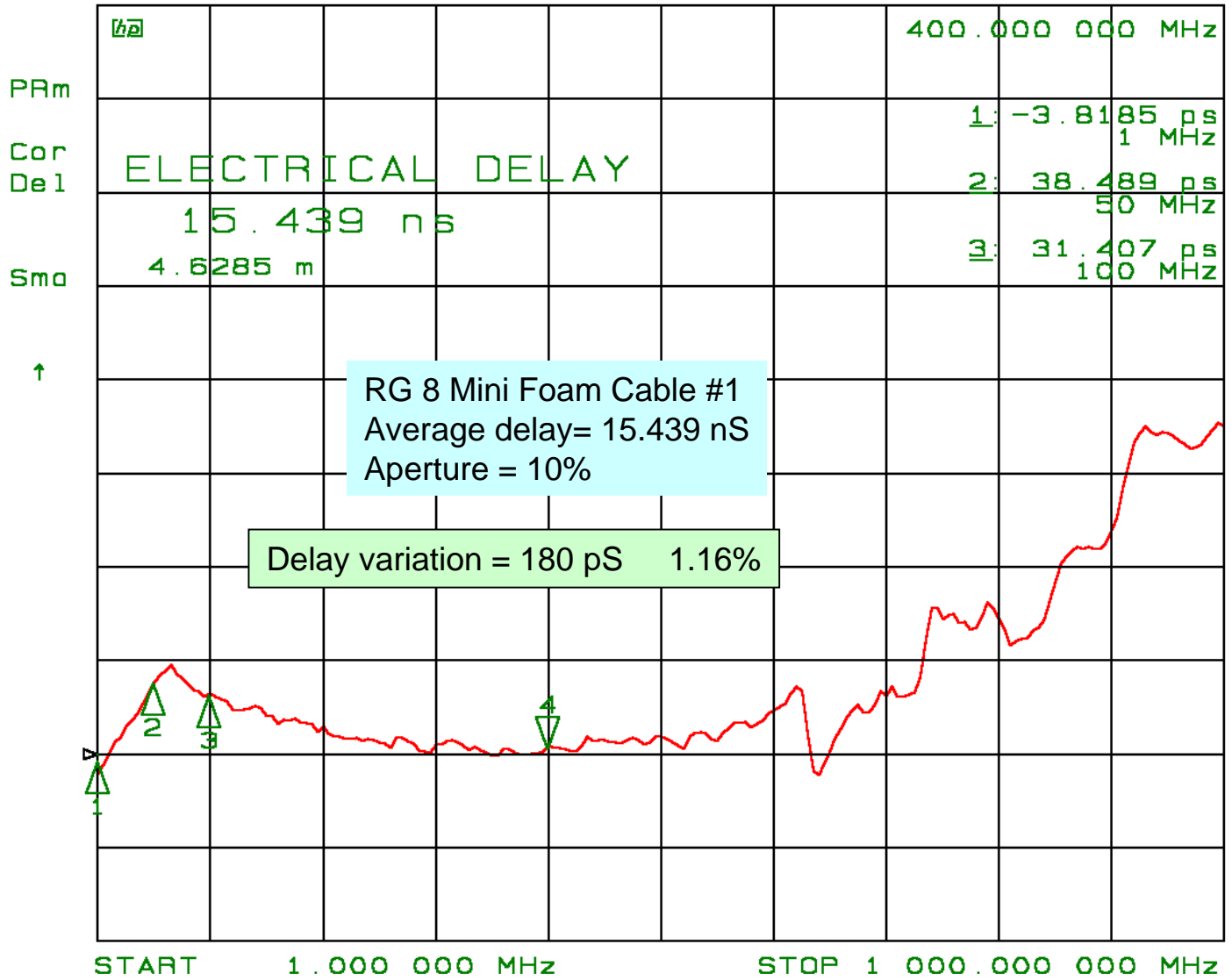
RG8 CABLE MINIFOAM approx 15 ft.

20 Jun 2003   15:53:59

CH1 S$_{21}$ log MAG   2 dB/   REF 0 dB   1:-10.223 dB

914.500 000 MHz

PRm

Cor

Del

Excessive attenuation
in this region,
but S11 is OK

0 dB

10 MHz   100 MHz   1000 MHz
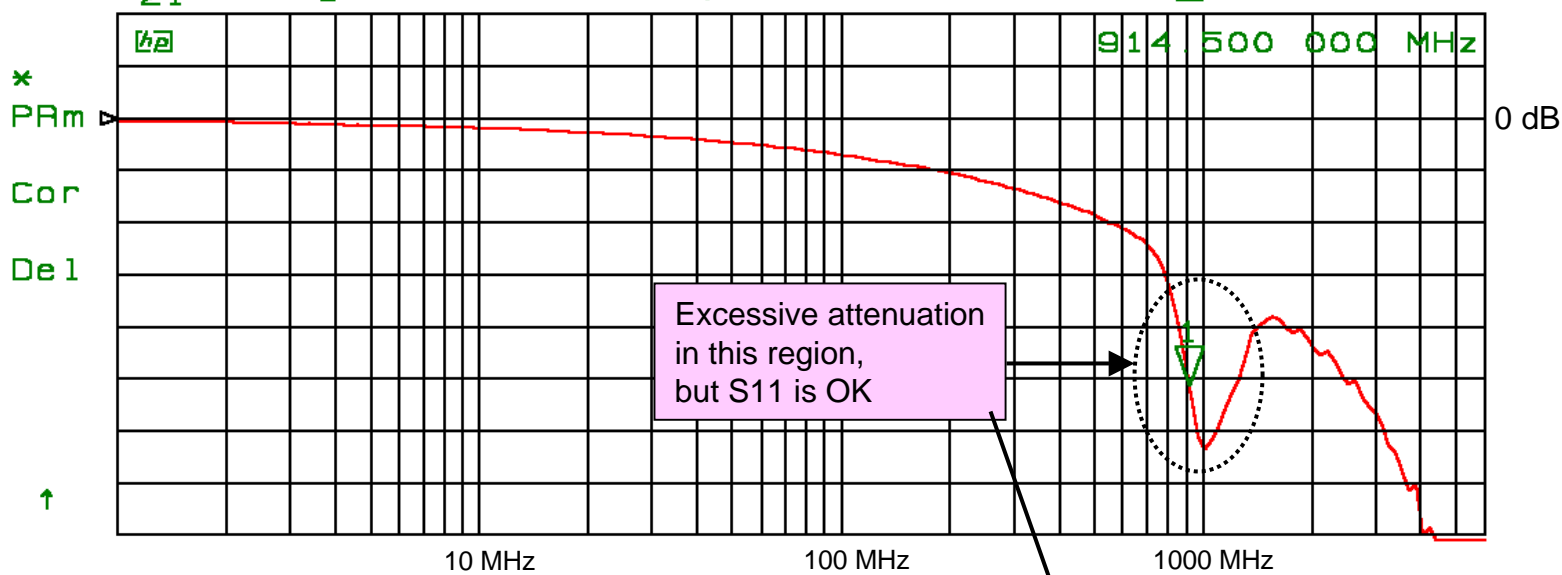
CH2 S$_{11}$ log MAG   10 dB/   REF 0 dB   1 -28.007 dB

914.500 000 MHz

PRm

Cor

0 dB

START   1.000 000 MHz   STOP 6 000.000 000 MHz
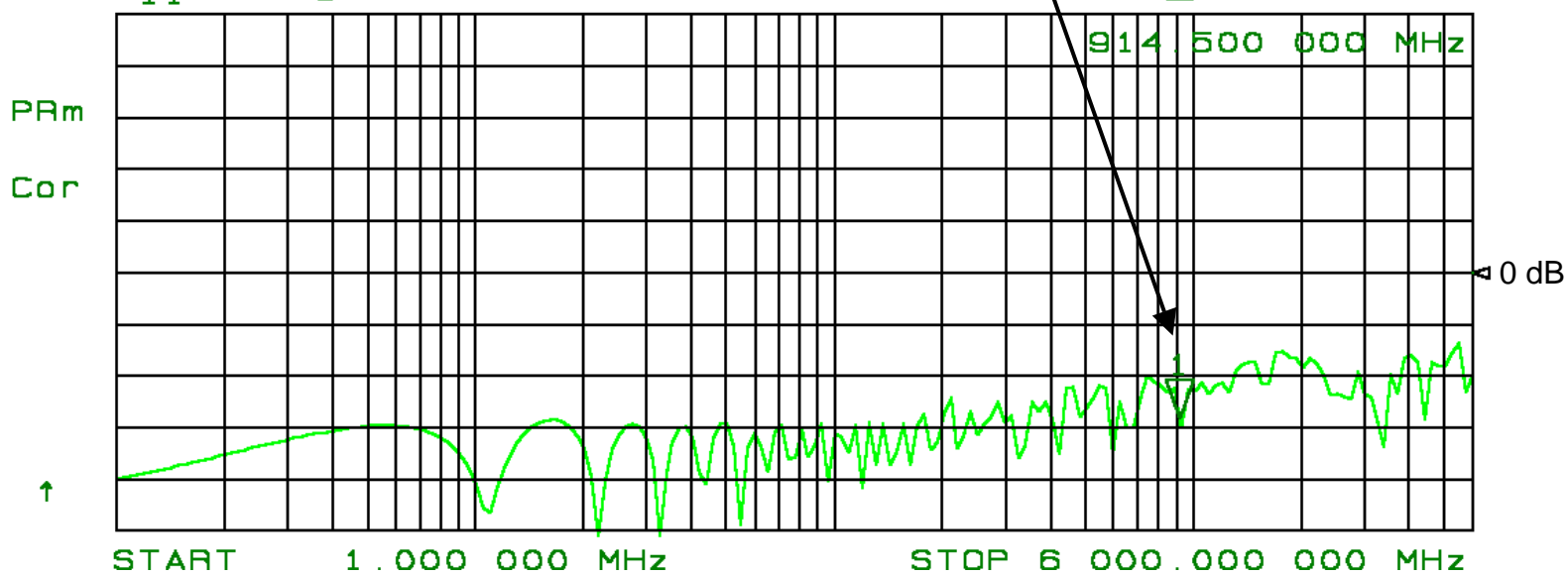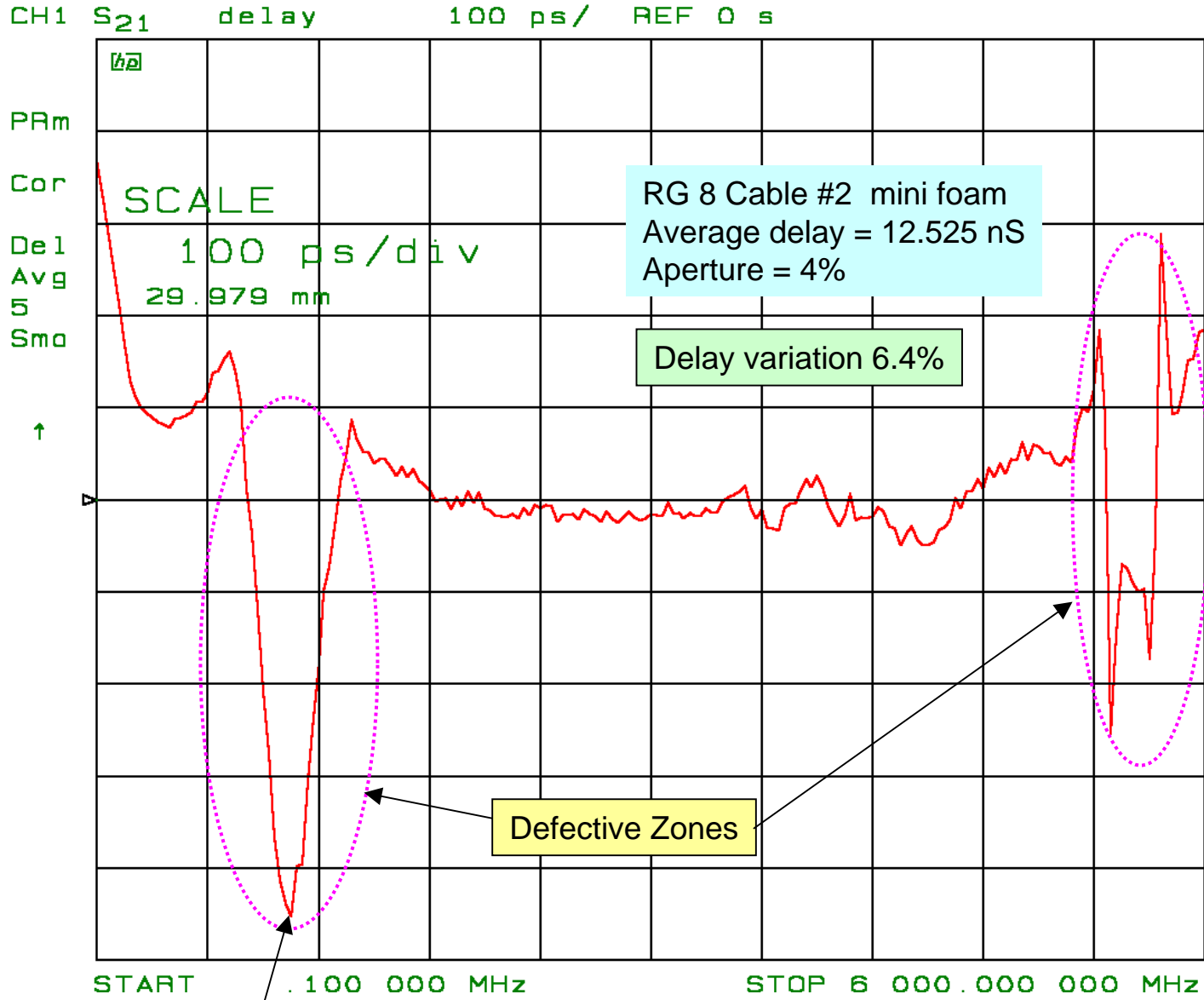
Conclusions and Observations

- In general the measured delays decrease until about 300 MHz, where delays will stabilize. A couple of cables showed a delay increase after this plateau.

- For the "standard" coaxial cables measured, the total delay variations from 1 to 1000 MHz were about 1 to 2 % of the total delay.

- Very good cables will exhibit 0.5 % delay variations.
  These cables will support the fastest data speeds.

- Conceivably the delay variations should be limited to approx. 20 % of the bit duration, over the frequency range of the data pulses.

- Minifoam RG-8 cable (sample #2) gave much worse results, with 6.4 % delay variations. It also showed a 6 dB dip in S21 at 1 GHz.
  The S11 was OK however.
  The RG213 sample also exhibited the same effect, with S21 dipping slightly (0.25 dB) at 430 MHz and giving a dip in the delay as well.