APD Fast Timing Test at PSI

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Dec. 1, 2011

We are planning a test beam run at PSI this evening in connection with a DOE Advanced Detector R&D grant of which Kirk McDonald(Princeton) and I are co-PI's. The primary application of this technology would be to allow TOTEM to run at full luminosity (since it enables a very precise time measurement of leading protons) and thereby add a forward proton measurement to the CMS data. The same idea would, of course, allow ATLAS to record forward protons at full luminosity from an enhanced ALFA configuration allowing proton measurement in the LHC's bend plane.

In an earlier paper we demonstrated that this technology would allow sub- 10 picosecond time resolution on the leading proton- even after a 1 year exposure to displacement damage by the radiation environment in the vicinity of the Roman pots at ~240m. The primary source of damage is due to the ~10's of MHz/cm^2 of 7 TeV protons crossing the detector.

It is unlikely that another technology would be better suited for this problem. For example, even with the 2012 projected operating conditions there would be ~2 leading protons per bunch crossing in the detector on average due to physics (SD) alone. The first measurements by TOTEM show that the actual rate, including other sources is higher than this.

Therefore it is critical that a technology be identified which can be easily scaled to small pixel size. Our choice of deep depleted APD's meets this requirement. RMD has made available new 8x8 mm^2 sensors for this test but it is also providing arrays down to 2x2 mm^2 pixel size for our later tests.

During the past 2 weeks we have been preparing a test setup using high frequency components from Philippe Farthouat and Fritz Caspers (PS rf group) and we are now getting high quality fast signals from the APDs when traversed by a RU^106 beta(see attached). The raw signals have an amplitude of ~6x10^5 electrons and a risetime of ~500 picosecond. In the attached figures you see the risetime degraded to ~700 picosecond due to the bandwidth of the 20dB 500 MHz front end amplifier. Both the bandwidth and the gain (since we are still scope noise dominated) will be increased for an upcoming test at Frascati but we already expect good performance in this configuration.

Lecroy has given us an SDA 7 Zi-A serial data analyzer to use for the next few weeks and we will use this exclusively for data acquisition of 3 waveforms (APD-1, APD-2 and a 3x3 mm^2 beam defining scintillator). We will trigger the scope on APD-2 and expect to take a few thousand triggers at 3 APD gain settings (G=150, 300, 600).

PSI is making available a beam of ~170 MeV muons with a rate of up to 10^5/cm^2/sec and removing the hadron component with absorber for this evening's run.

Request:

I plan to leave CERN at 2PM and arrive at PSI around 5-5:30. Unfortunately Alan Rothenberg, who was originally coming had to drop out at the last minute.

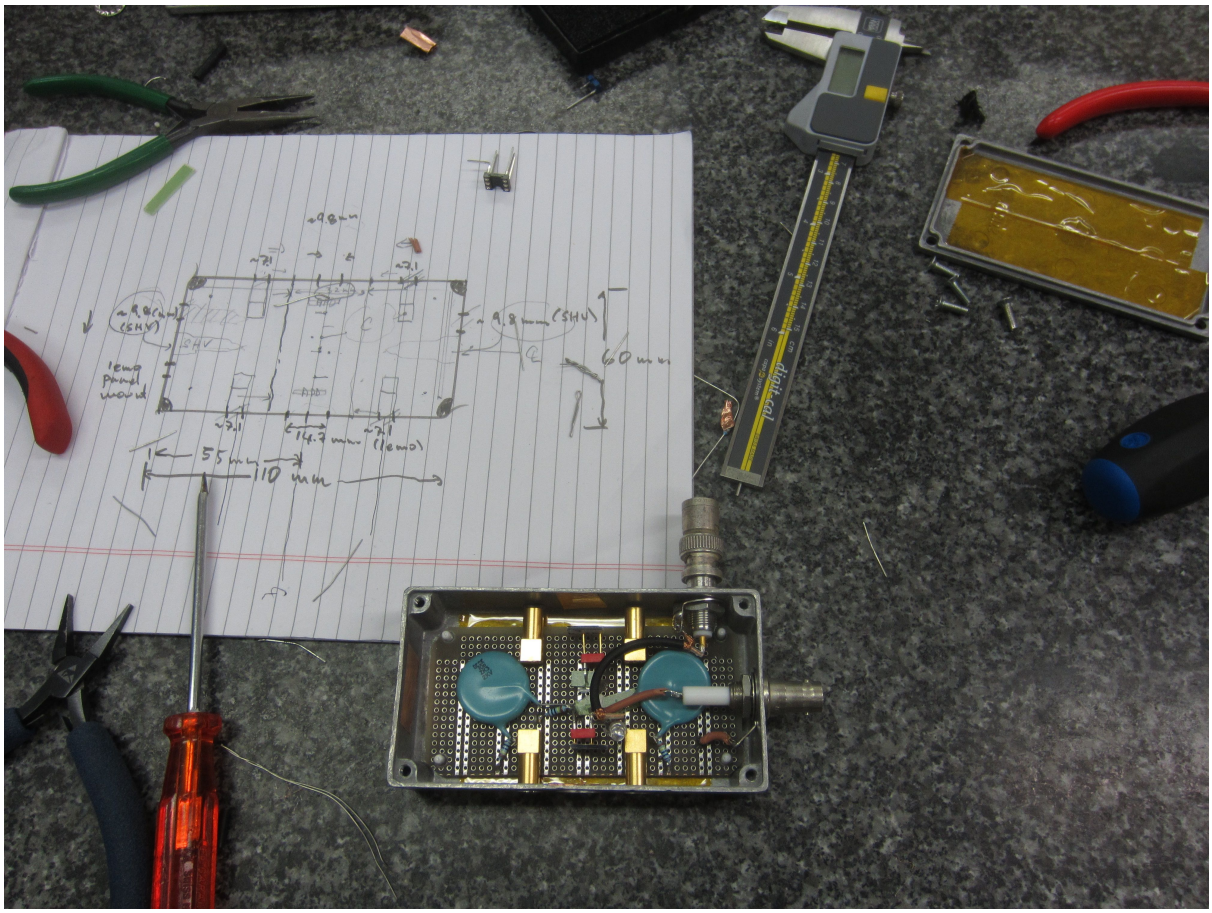
I am asking for someone who would have an interest in this technology to share in the driving and work with me in the testbeam this evening. We should be back at CERN tomorrow morning (the beam shuts off at 8 AM).

Please contact me on my cell at;

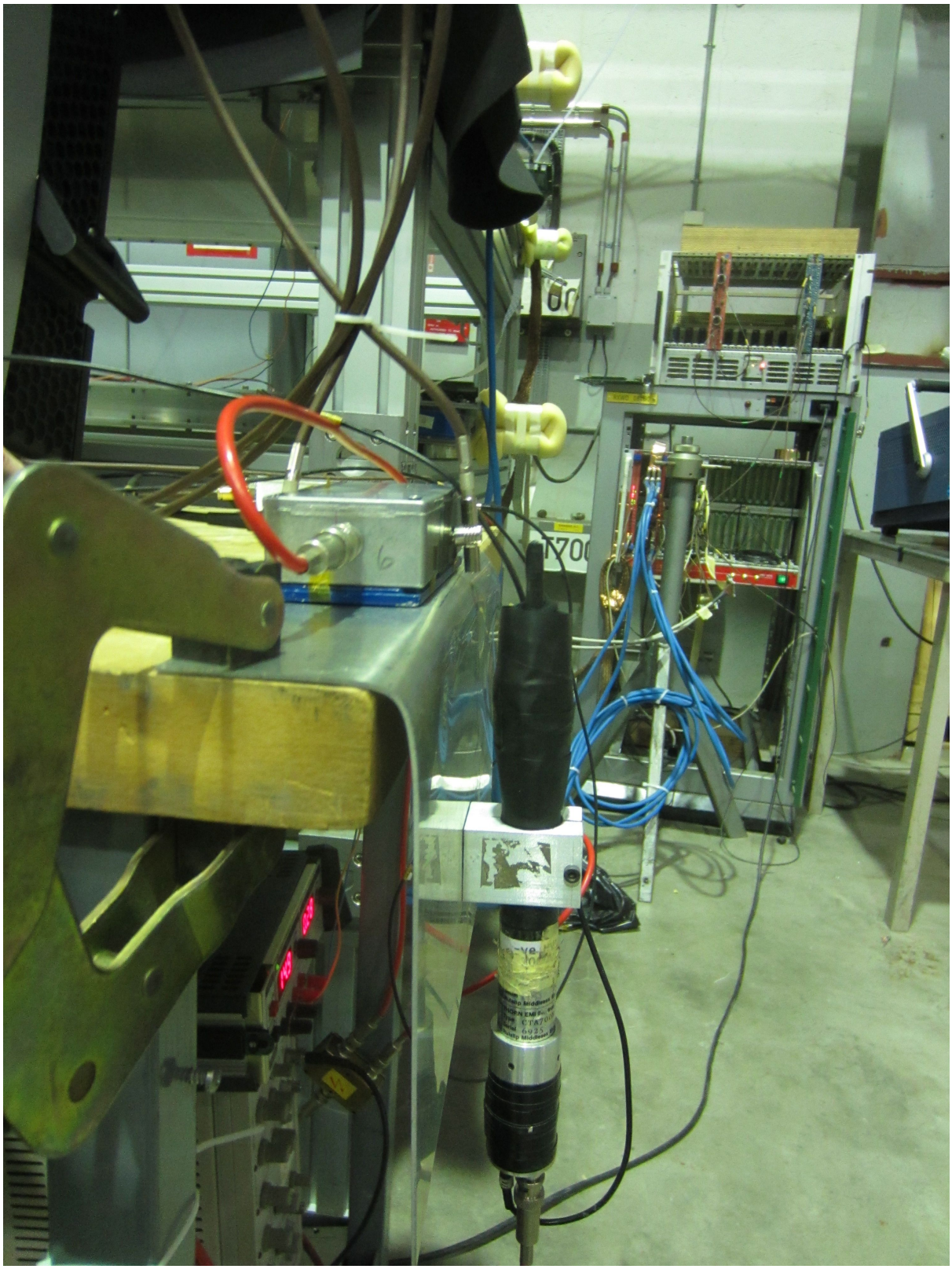
+41-786392790

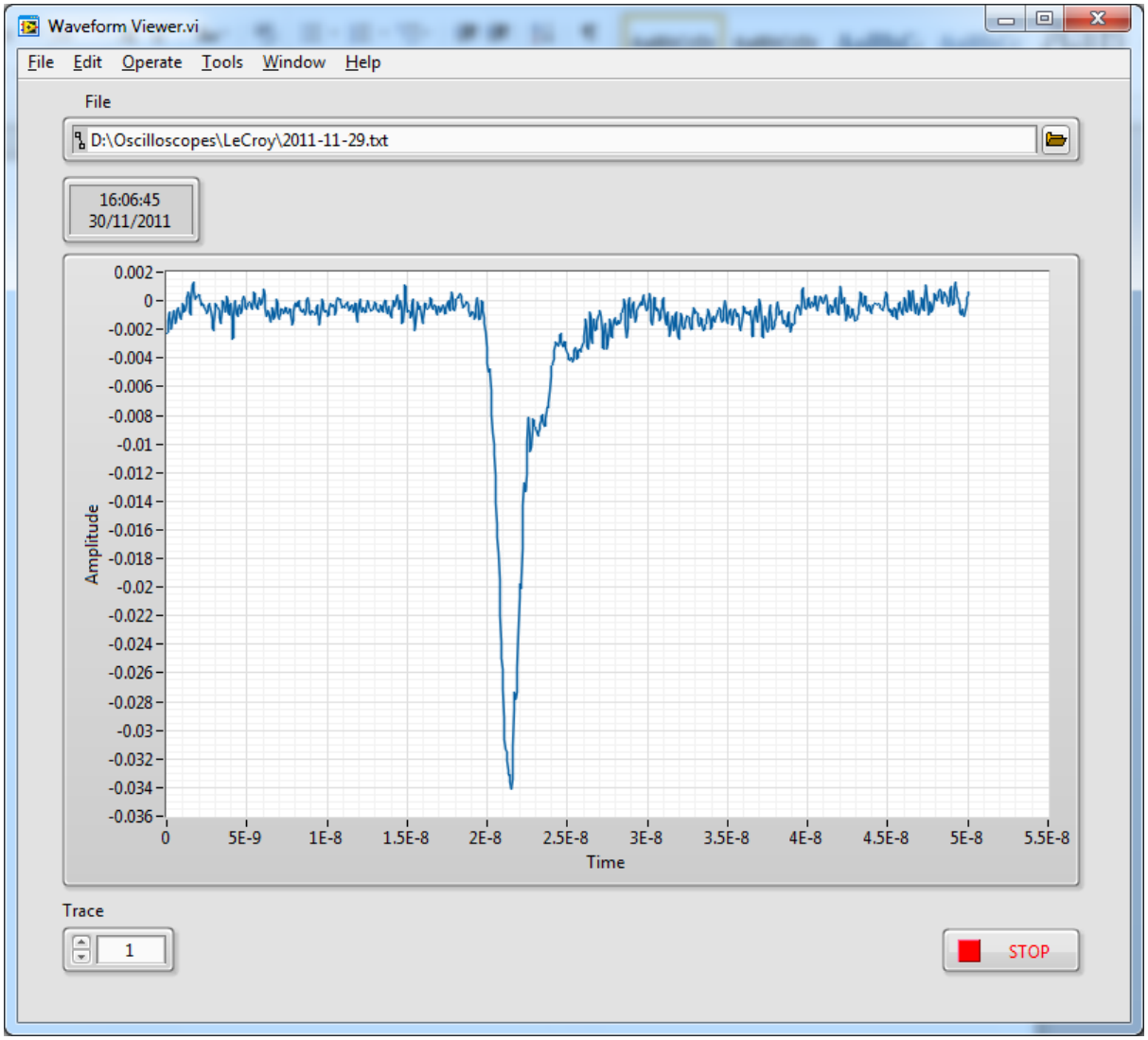
and by email.

Partly assembled APD telescope(the kluge board is suited for high frequency work since it has a ground plane on the underside).



Telescope for PSI test (only the components on the aluminium bracket will be placed in the beam).

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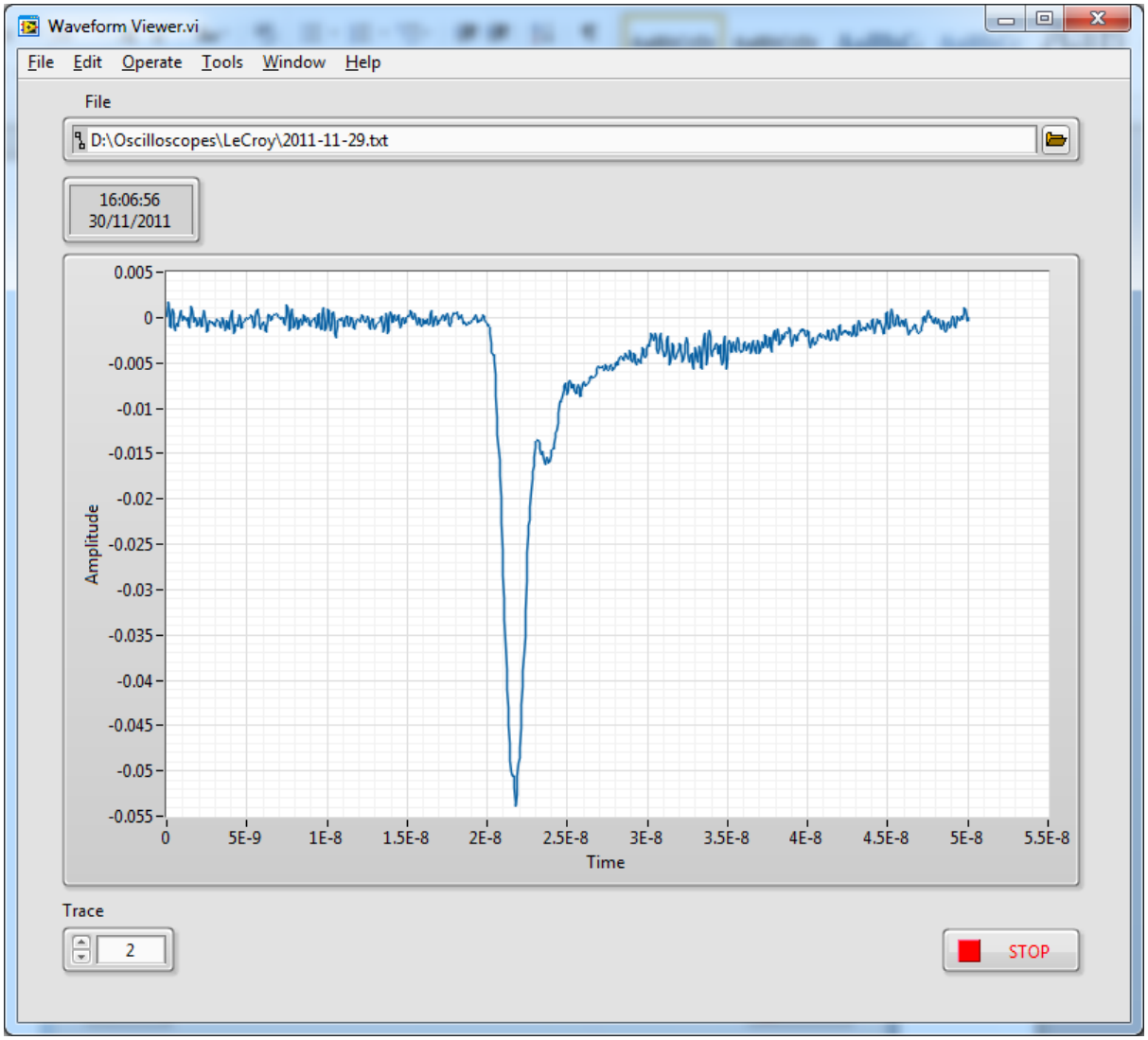
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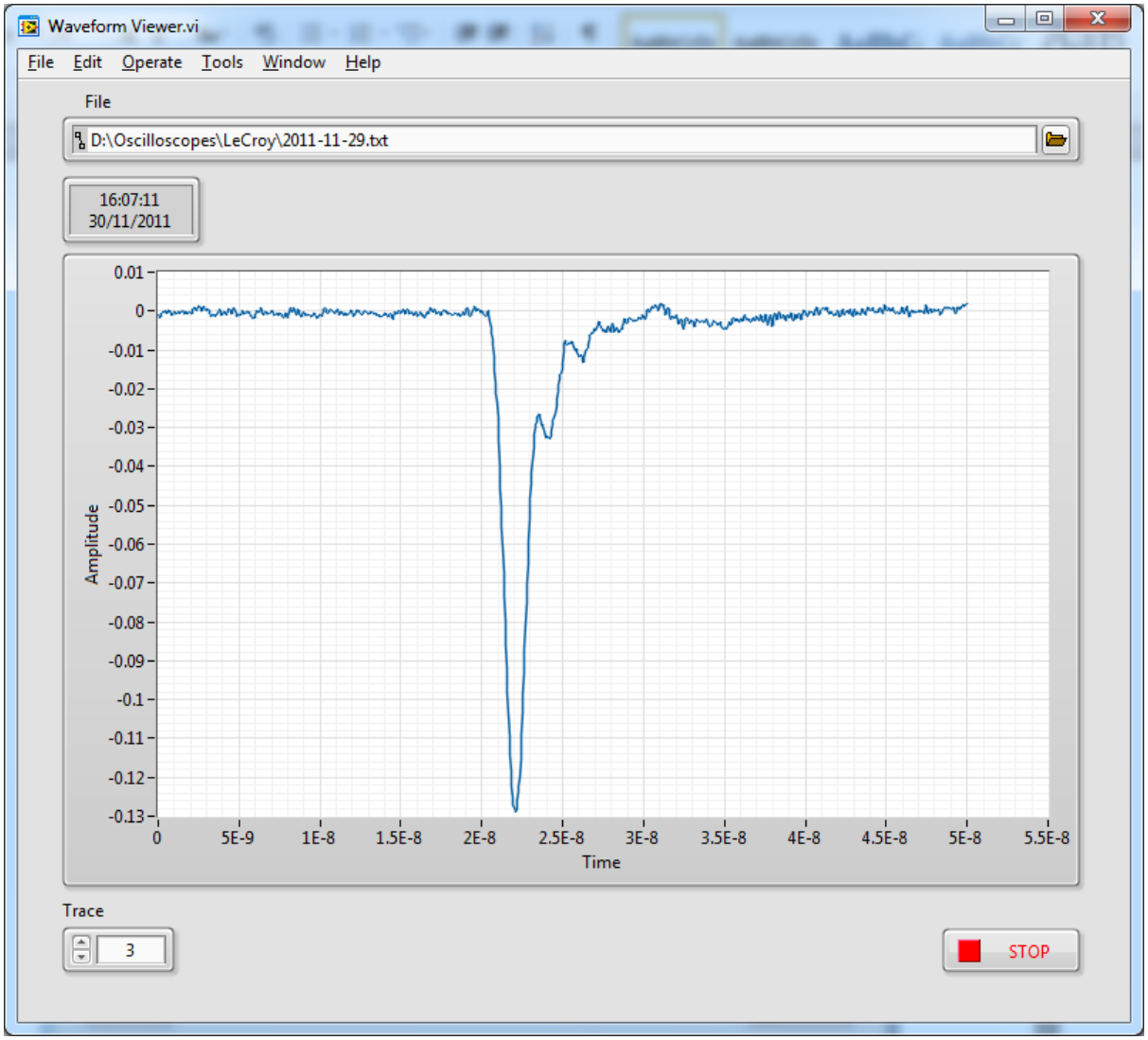
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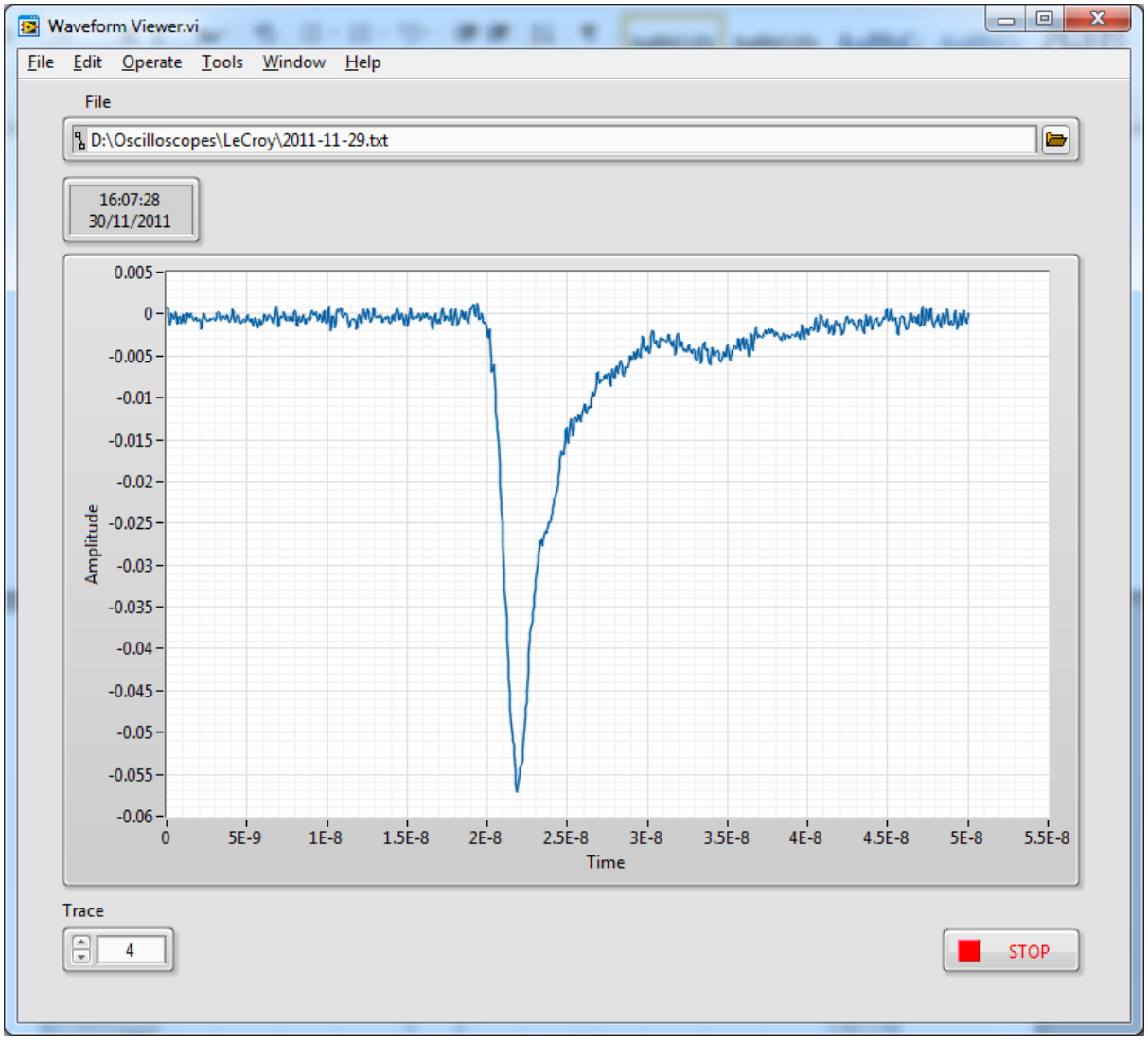
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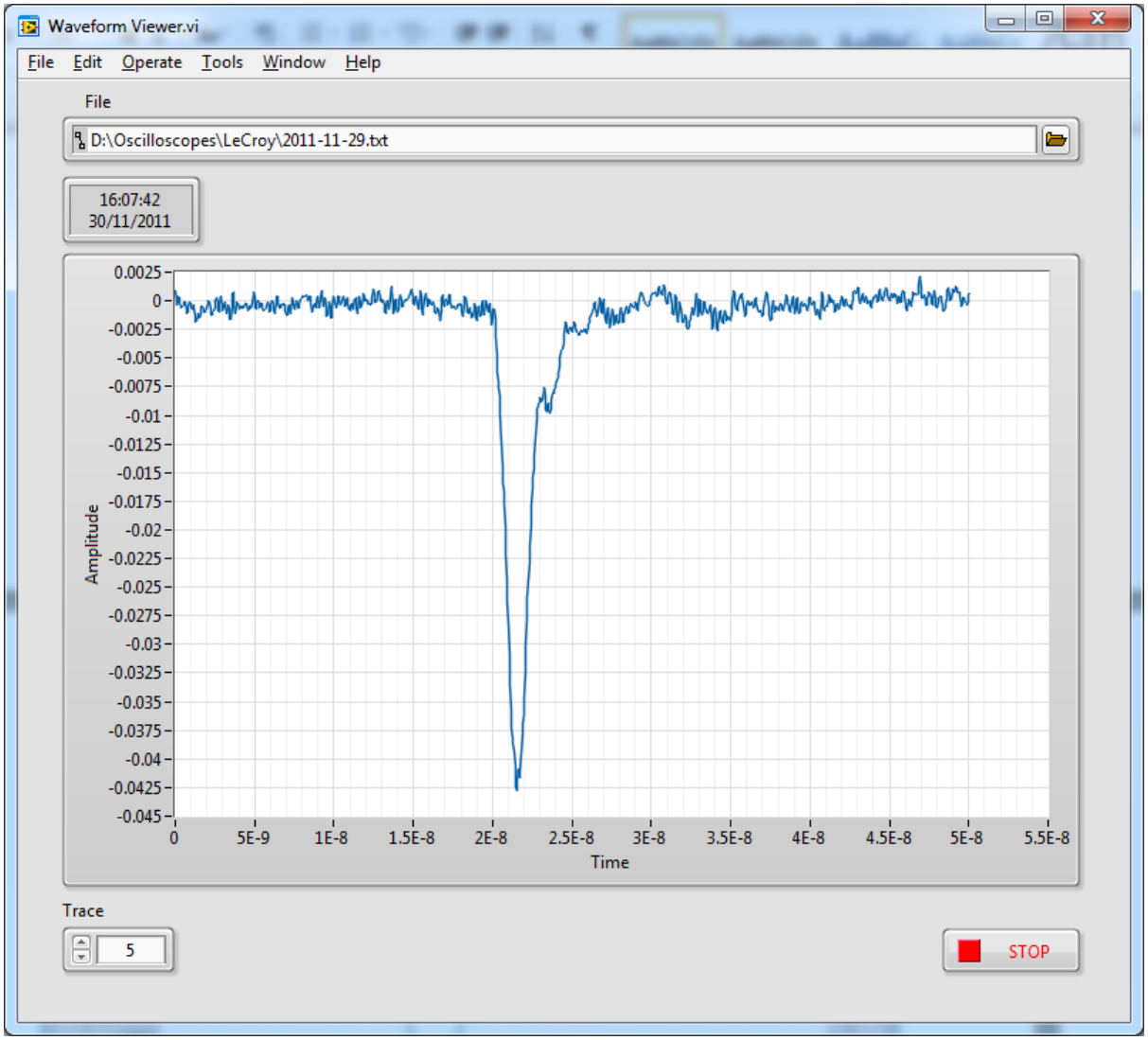
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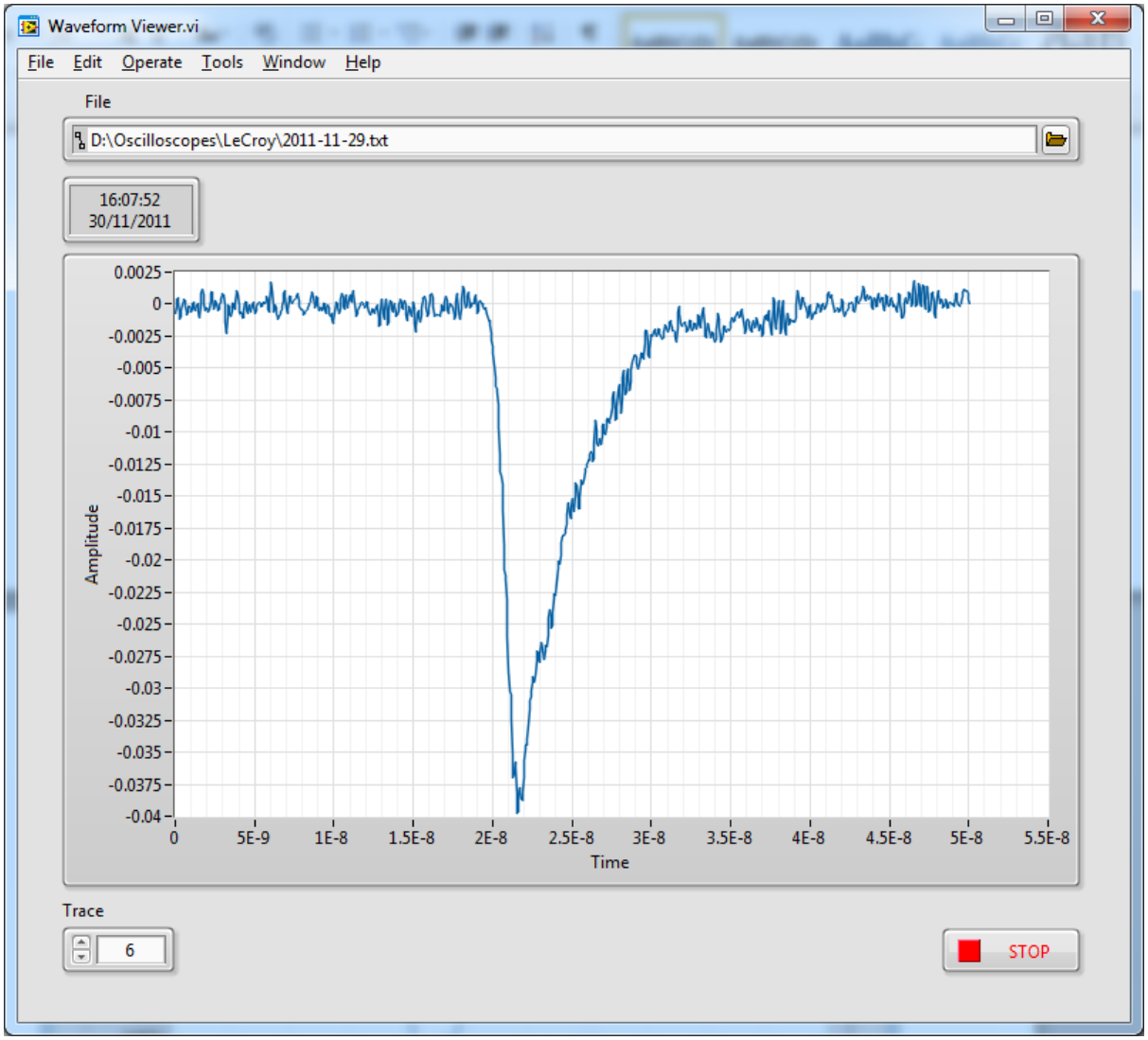
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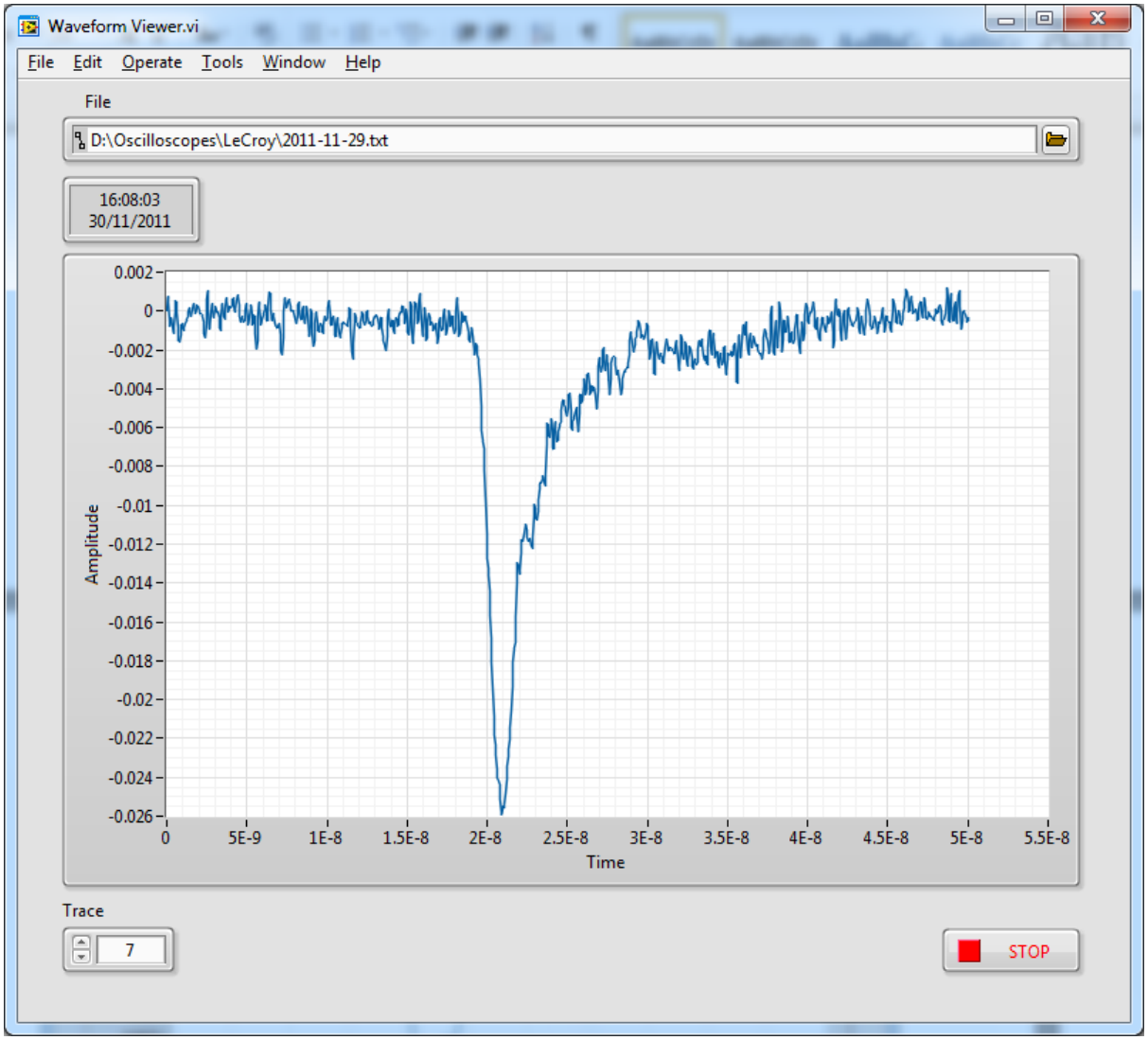
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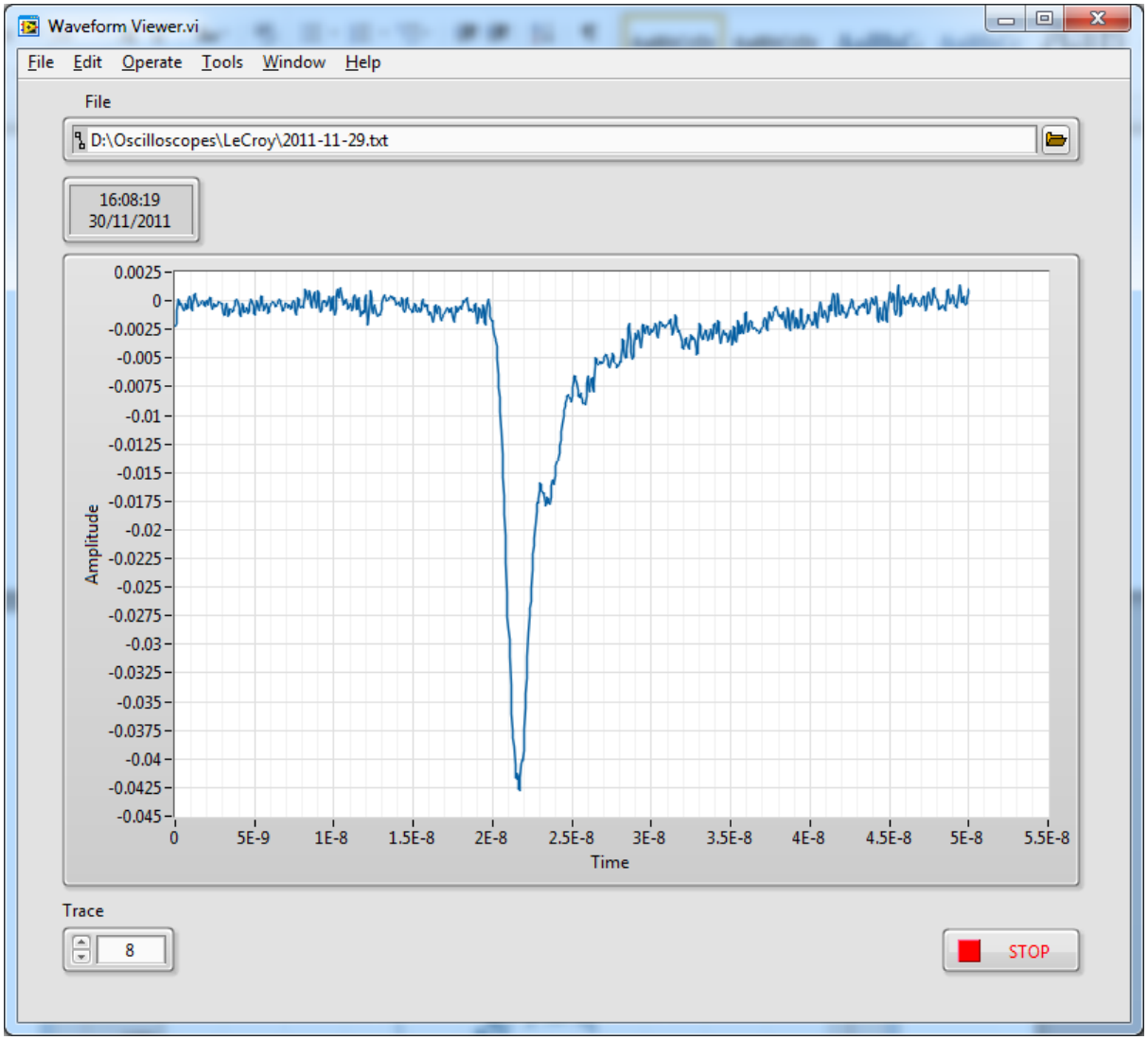
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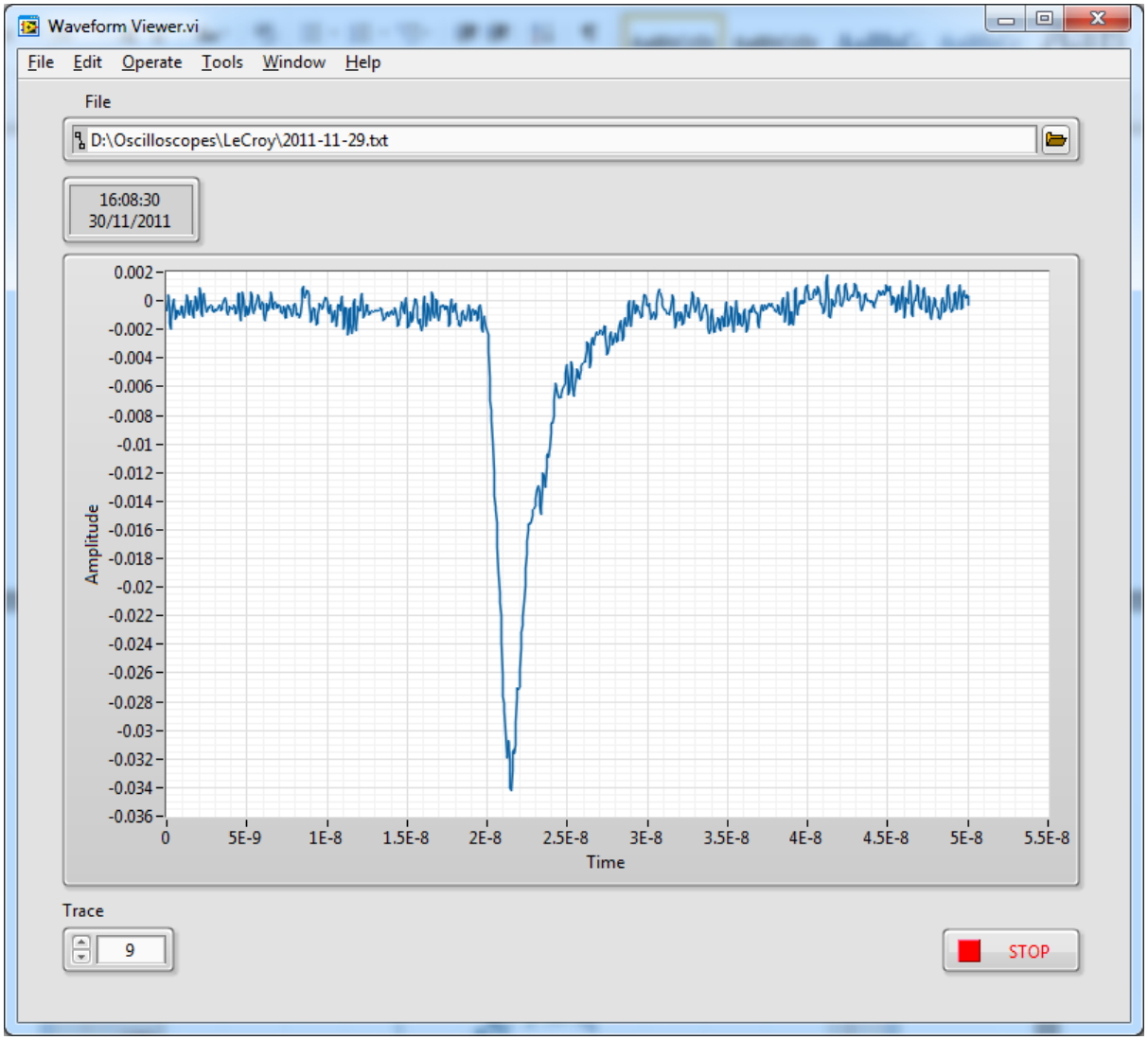
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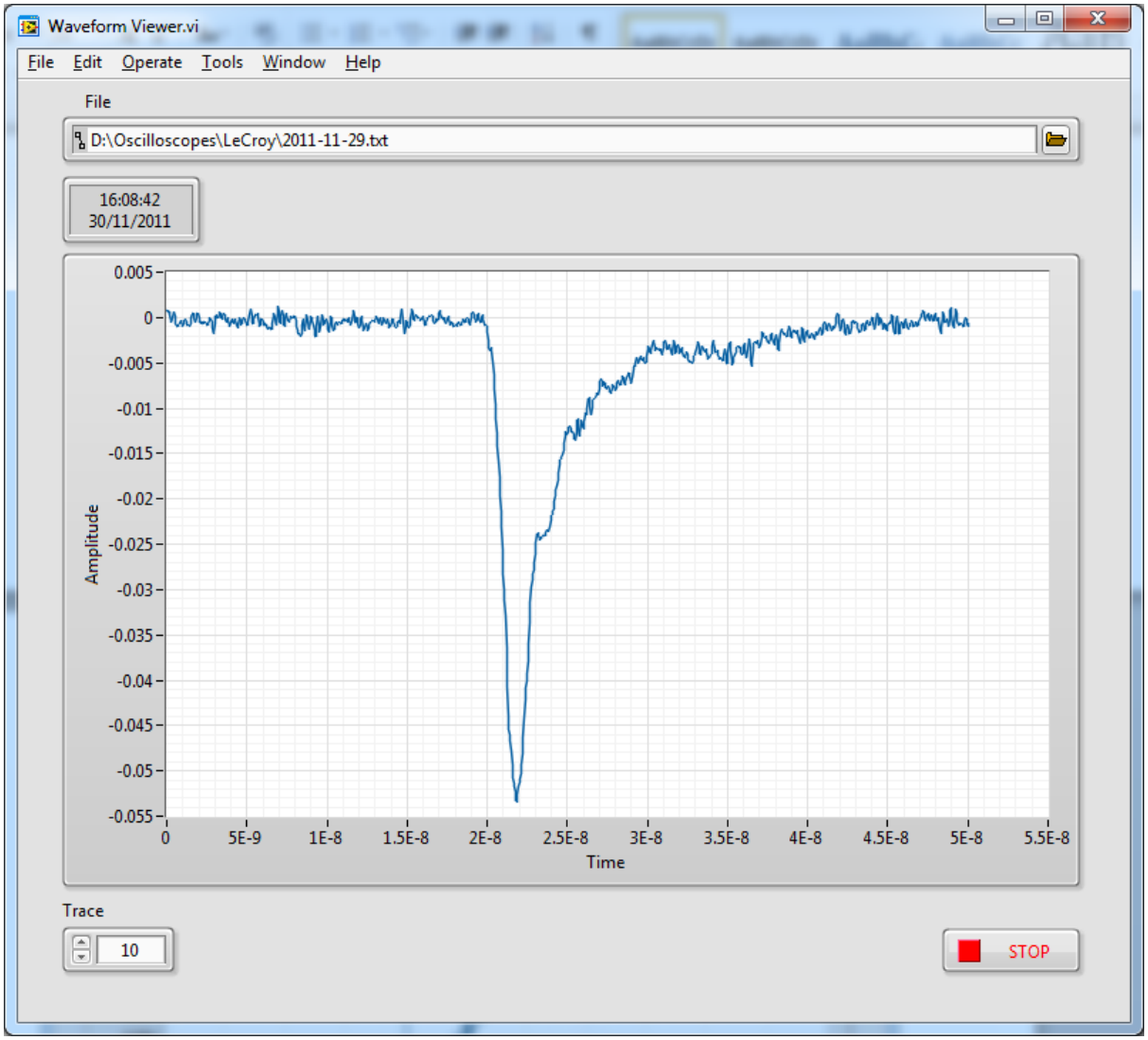
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