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Tungsten Wire & VISAR

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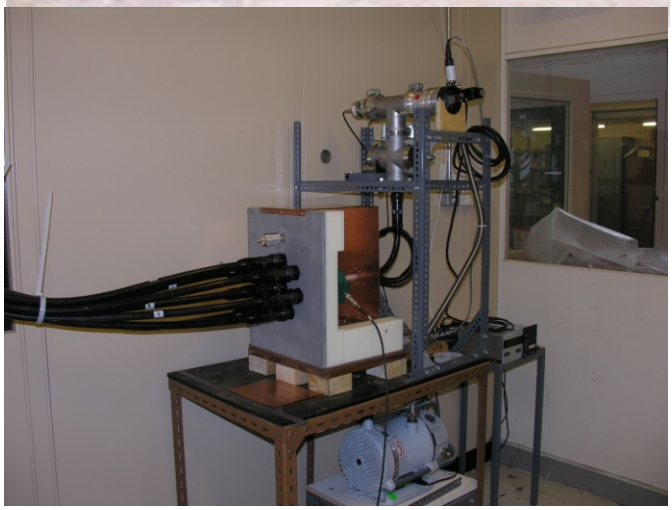
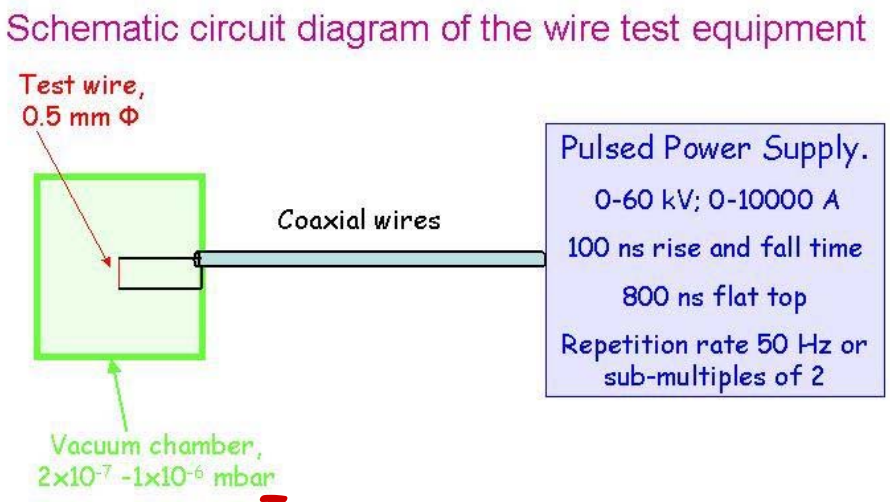
VISAR wire tests – Standard approach





Issues:

VISAR signal?

(for 0.5 mm diameter, 3 cm long wire and peak current of 6 kA)

Room temperature or high temperature (let's say 1500K)?

Can we see a signal with 10m delay-leg (we already have it) or we need a longer delay-leg (let's say 30m)?

Radial or longitudinal oscillations?

We can measure radial or/and longitudinal displacement of the wire

Results of calculations -> following pages

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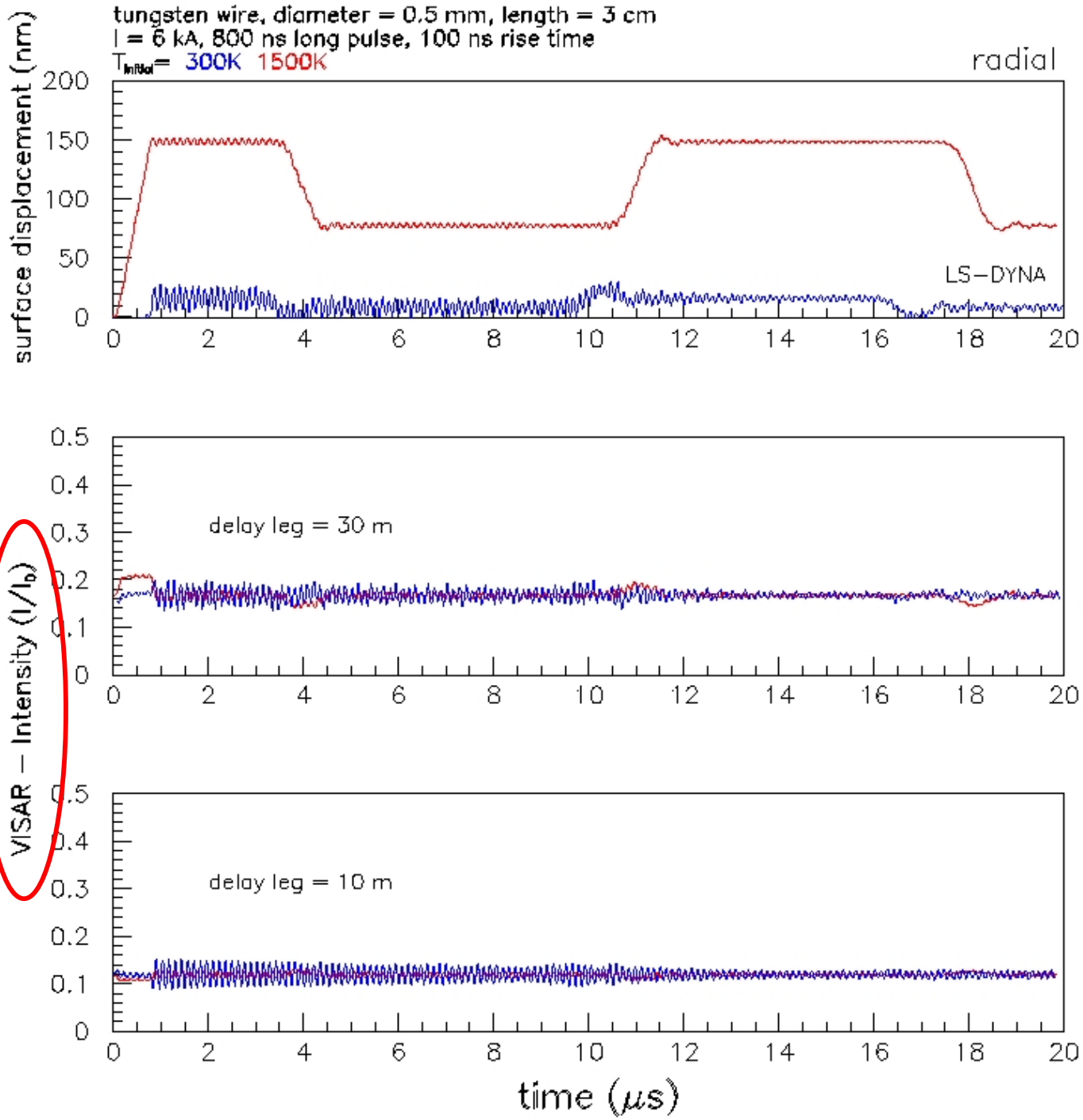
Results

Radial displacements



VISAR signal:

- flatline

(for room and high temperature; for 10m and 30m delay-leg)

Conclusion:
We won't see anything here

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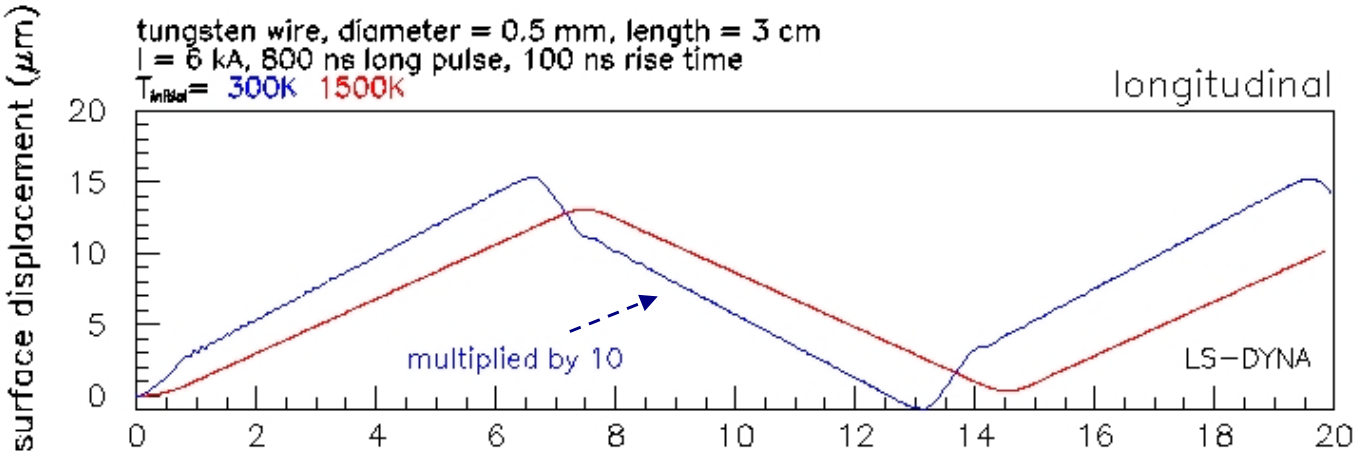
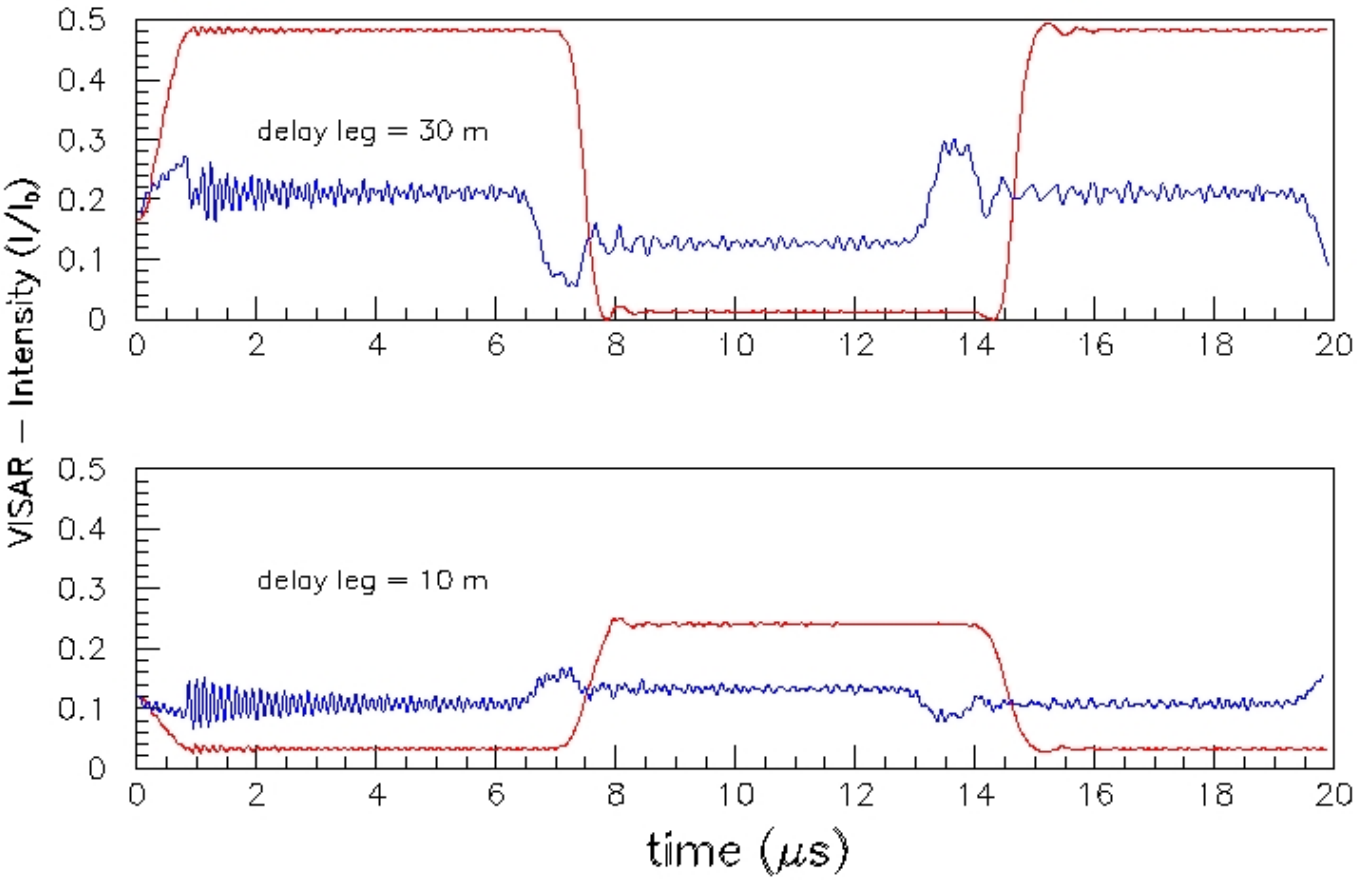
Results

Longitudinal displacements





VISAR signal:

- very nice (decent) *for 30m delay-leg at high* (room) *temperature;*

- decent (low) *for 10m delay-leg at high* (room) *temperature;*

Conclusion:
We have to focus on longitudinal oscillations

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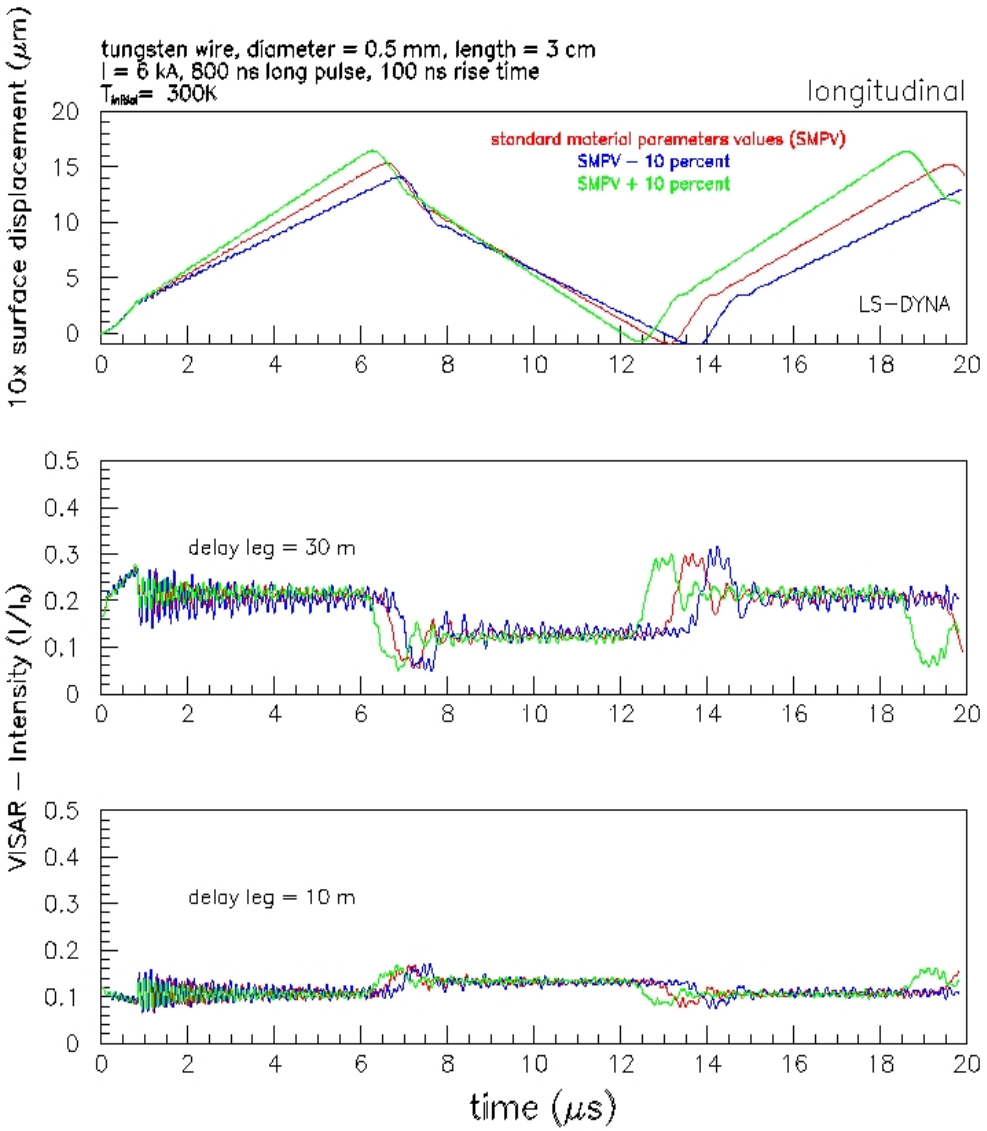
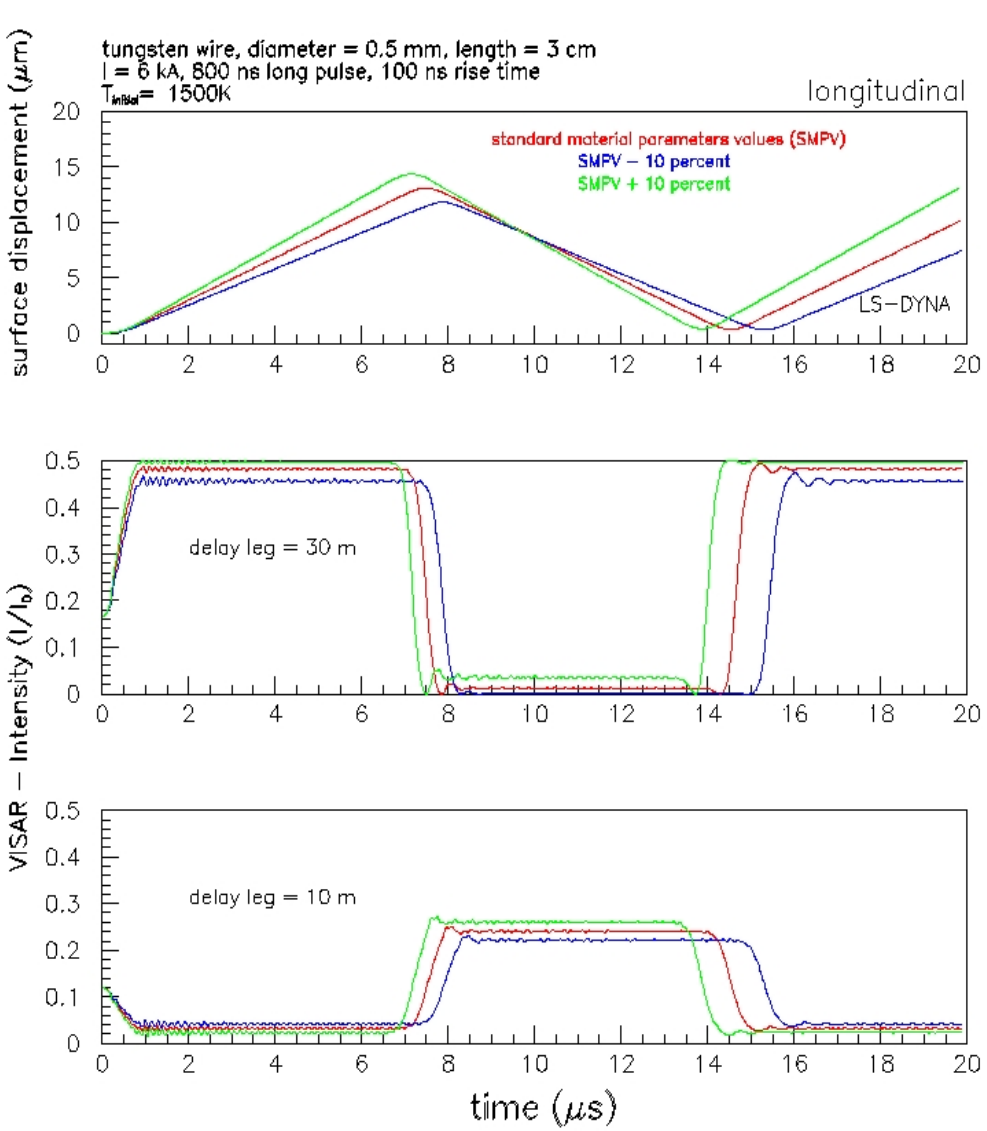
Sensitivity of VISAR signal on material parameters values

Room temperature



High temperature



If we have a nice signal, VISAR is sensitive to material parameters values. Here shown changes of VISAR signal for +-10% changes of material parameters (E, CTE). Change of E is responsible for time-shift of the signal.

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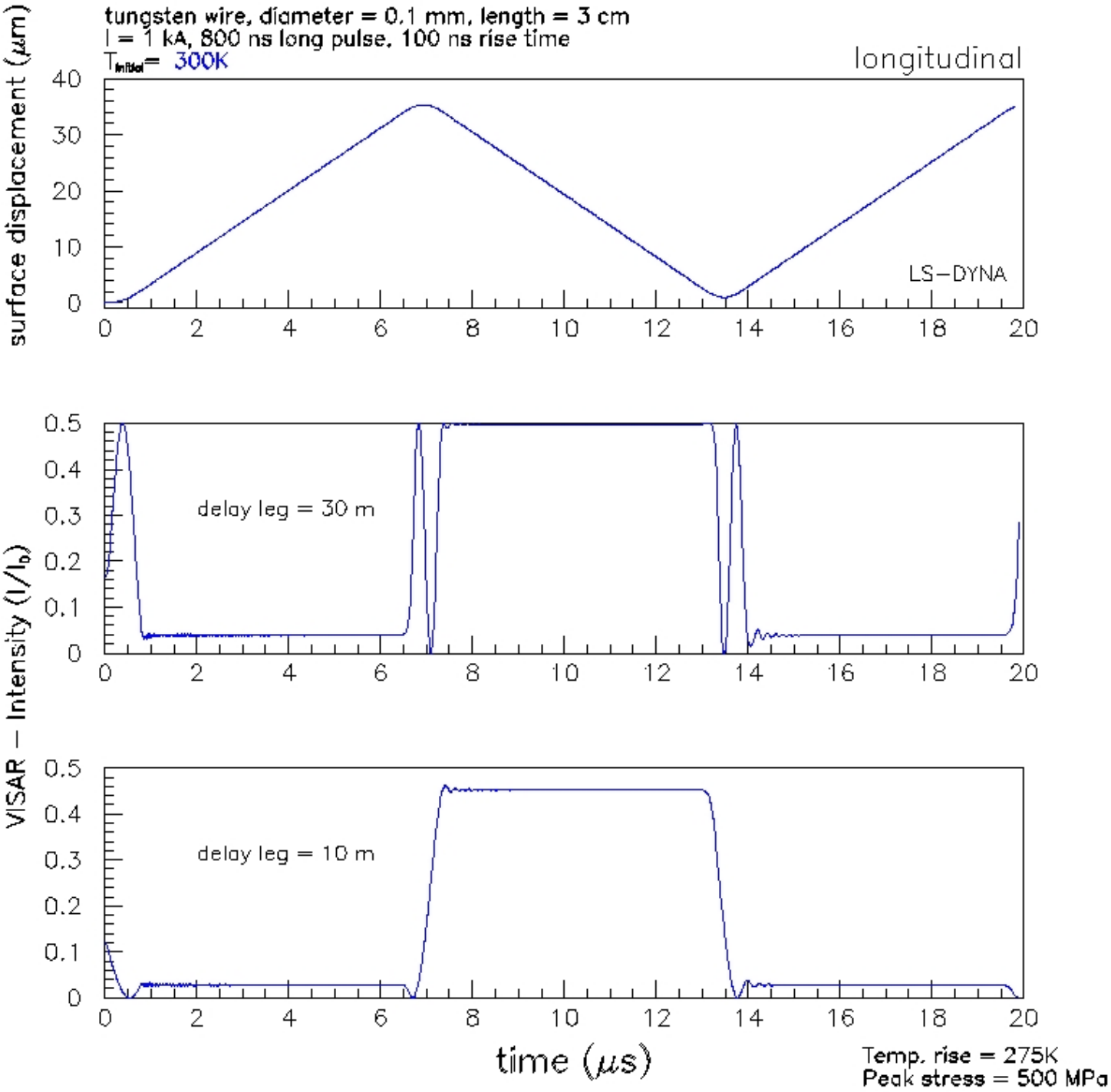
VISAR wire tests – Standard approach

Another possibility

Very thin wire (0.1 mm diameter) and (only) 1 kA current

Beautiful VISAR signal at room temperature with 10m delay-leg

BUT…



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A few words about VISAR's laser beam spot size…

- VISAR signal intensity has been tested as a function of the wire diameter
- Laser beam has been pointing at the end of wire (end of wire has been polished)
- Nice signal has been observed for 0.5 mm diameter wire
- Very low signal has been observed for 0.3 mm diameter wire
- Problem: Laser beam spot size is too big (=> 0.5mm diameter)
- Consequence: We can hardly see a thing for wire diameters smaller than 0.4 mm

So, the only chance to do the test with existing (10m) delay leg is to pulse a wire until it reaches high temperature* and then try to measure the VISAR signal

*The difference in a wire surface displacements at room and high temperature (see upper plots in Slides 3 and 4) is a result of very low tungsten resistivity at room temperature (10x lower than at 1500 K).

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VISAR wire tests – Alternative approach

While waiting for 'refurbishment' of our power supply, there is Roger's idea to shock a wire by discharging the number (n~20) of capacitors.

- Parameters:
  - Voltage applied to capacitor ~ 50 kV; peak current ~ 950 A
  - Very short pulse (20 ns rise time, 30 ns fall time)
  - 'n' circuits in parallel (n=20)
  - Estimated temperature rise in the 0.2 mm diameter tungsten wire (at room temperature) ~ 130 K (similar to the NuFact target case)

Results of calculations of wire stress, surface displacements and corresponding VISAR signal as a function of wire diameter are shown in following pages.

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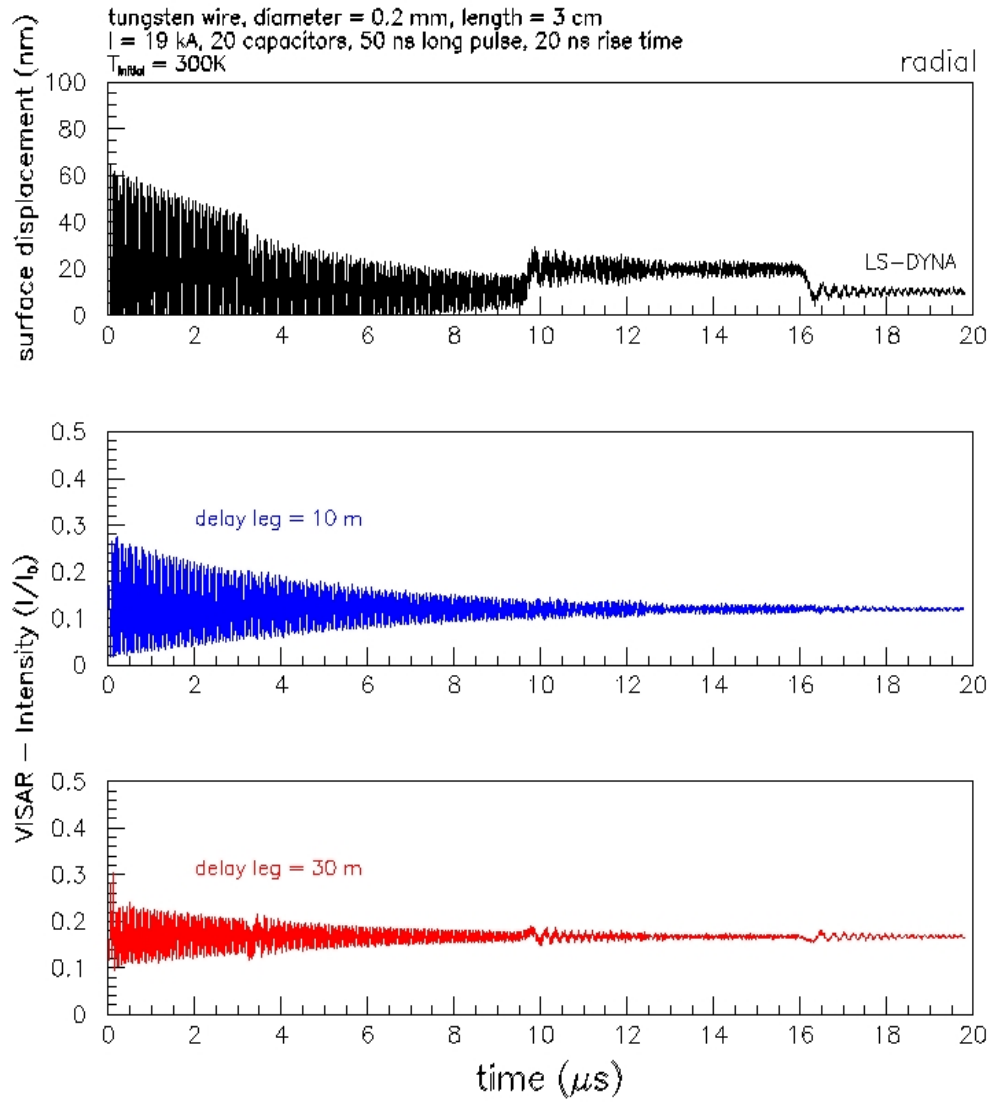
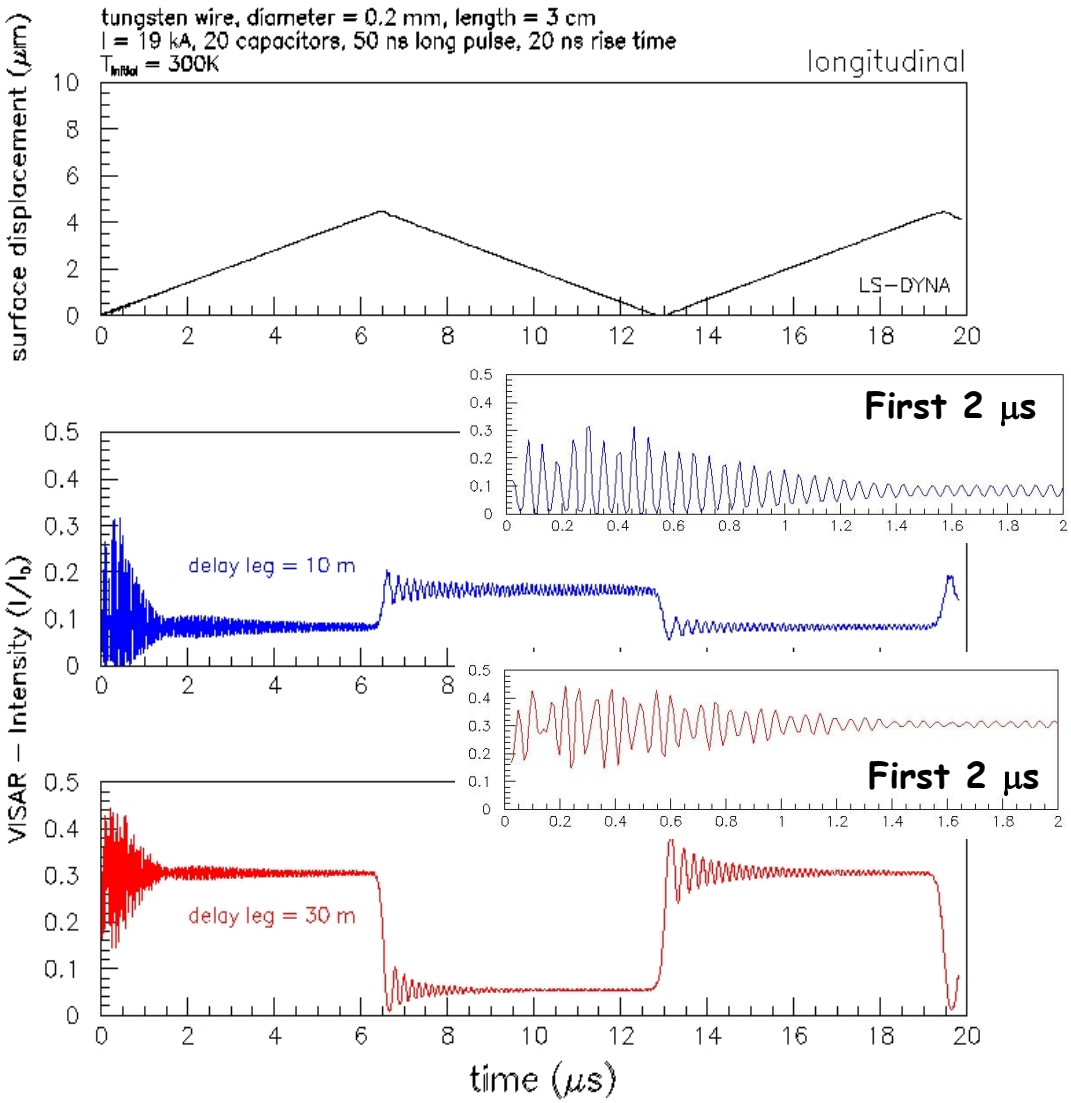
'20 capacitors' case - 0.2 mm diameter wire

end of wire





Decent signal for 10m delay-leg; radial movement that affects longitudinal one -> clearly seen at the beginning (see inset plot); shame that our laser-beam spot size is so big so the amount of reflected light is so small…

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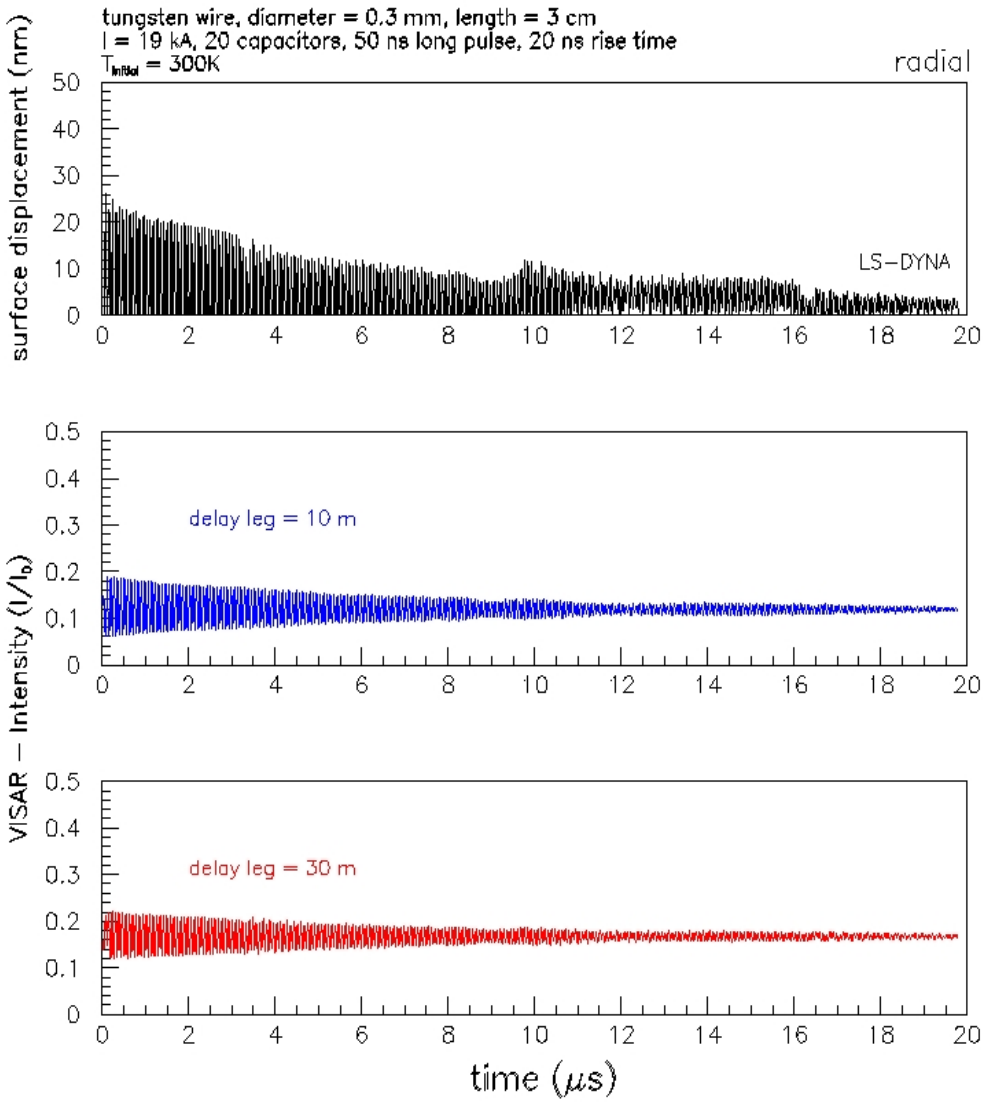
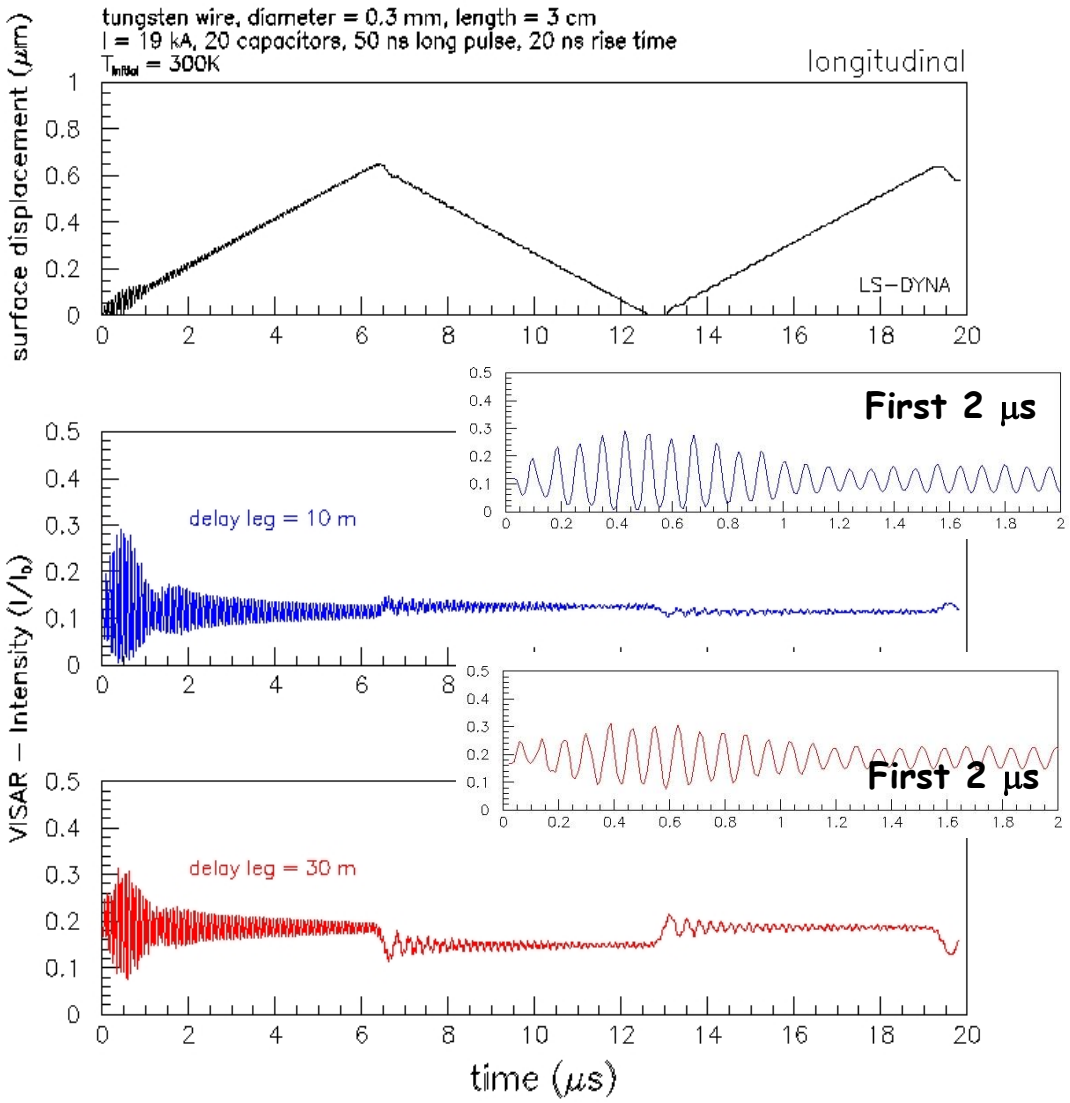
'20 capacitors' case - 0.3 mm diameter wire

end of wire





As expected, situation is much worse than for 0.2 mm diameter; temperature rise is only ~ 35 K; Lorenz force induced pressure wave starts to dominate…

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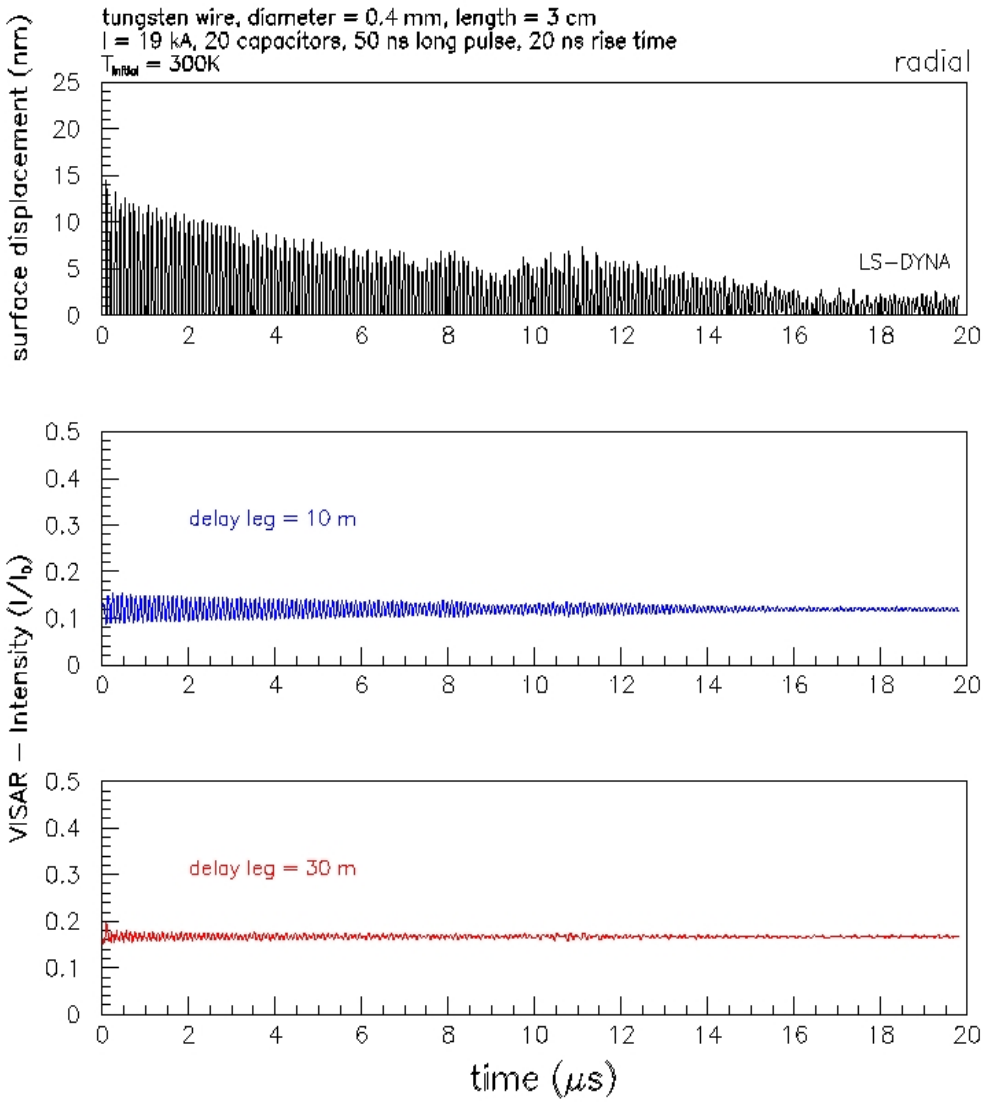
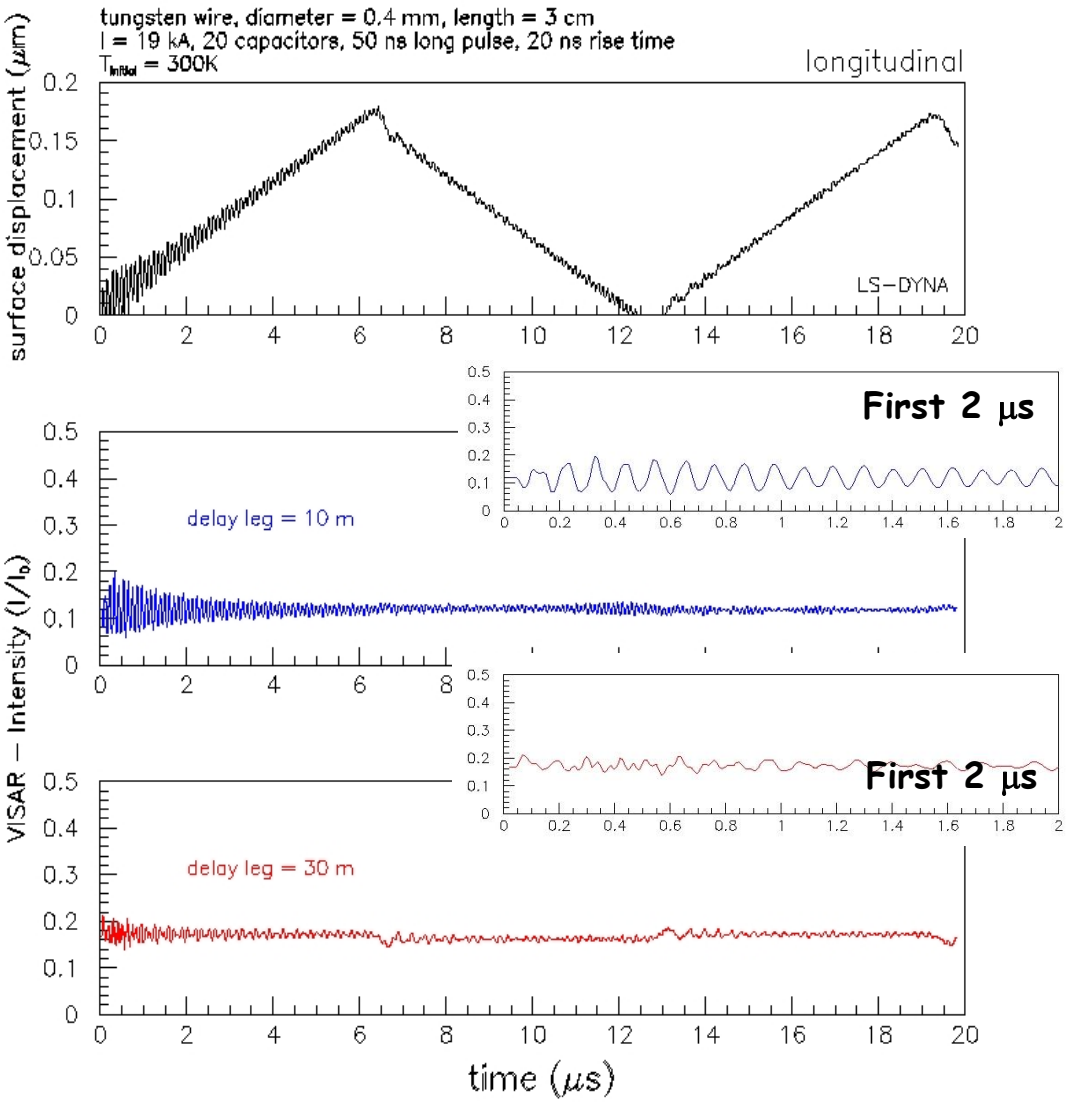
'20 capacitors' case - 0.4 mm diameter wire

end of wire





Practically no signal for 20 capacitors but may look promising if we add more circuits (see slide 13)

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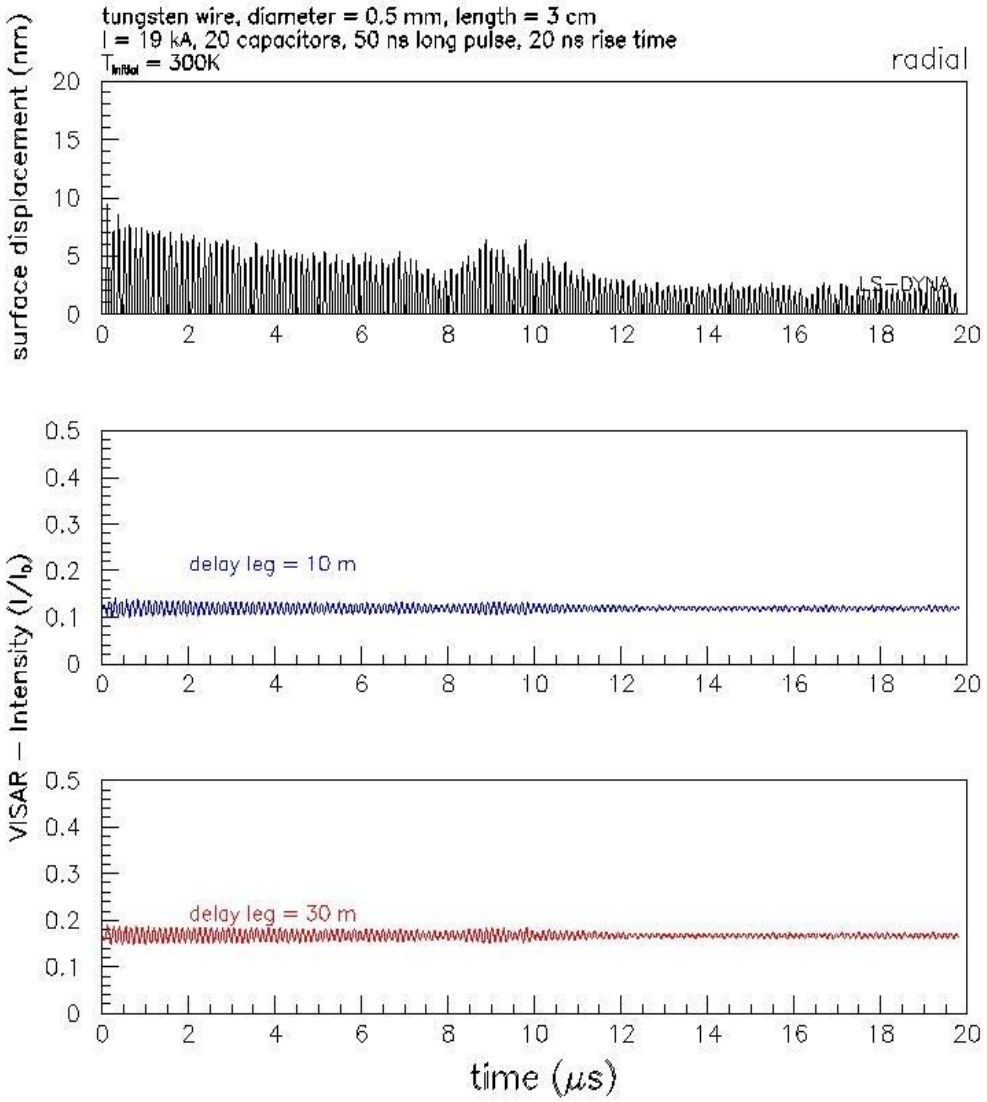
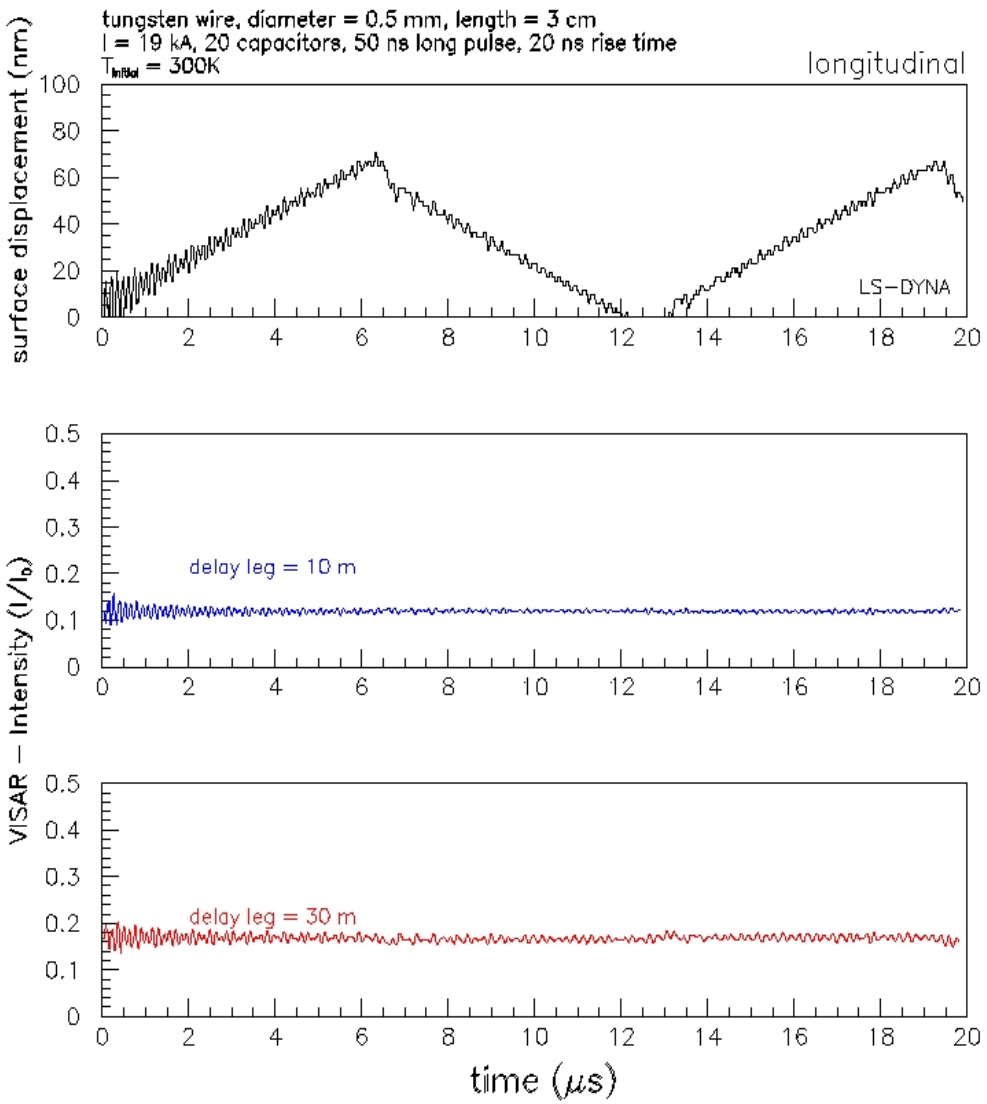
'20 capacitors' case - 0.5 mm diameter wire

end of wire





We could see a signal here without any problems if there is any. Unfortunately, we have a flatline – the wire is 'dead' (from the VISAR's point of view). More (but reasonable number of) circuits in parallel won't change the results.

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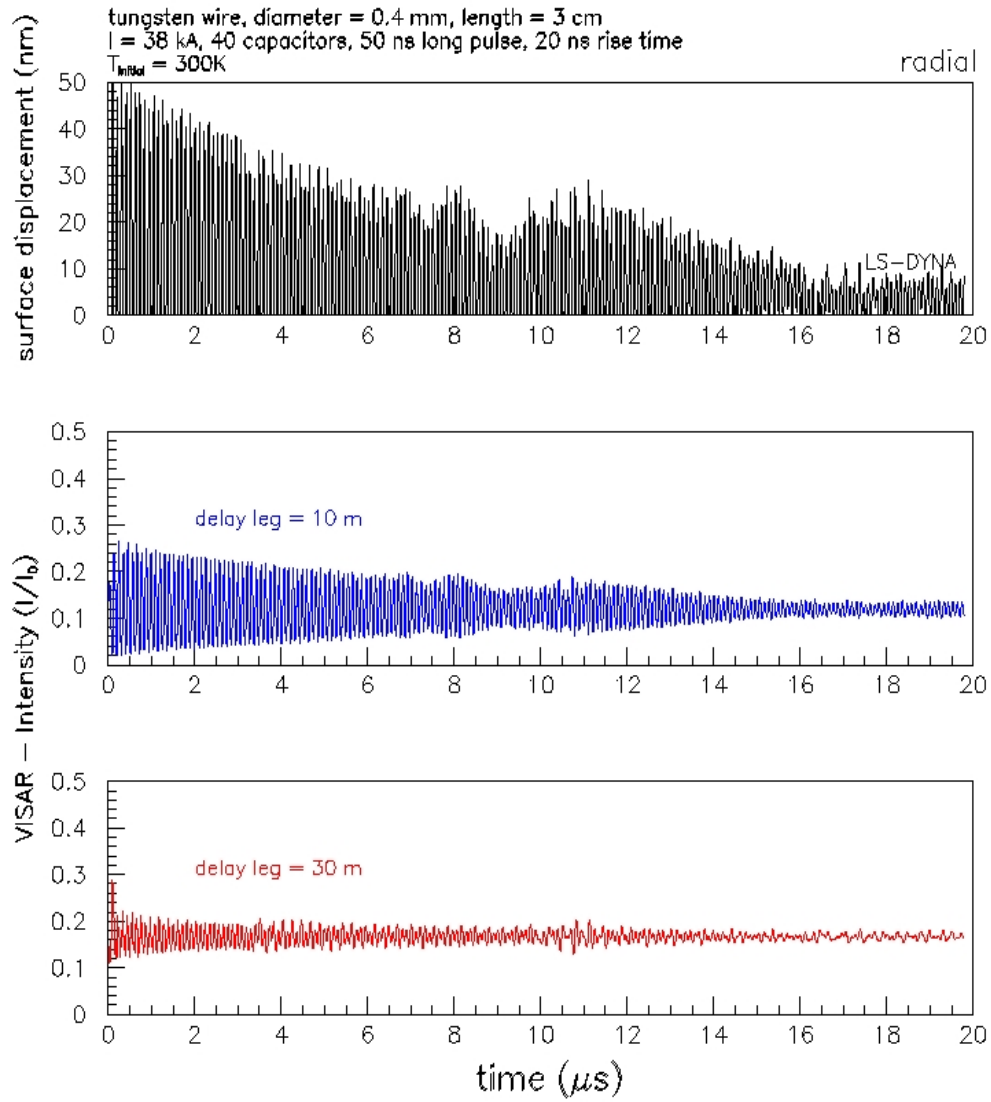
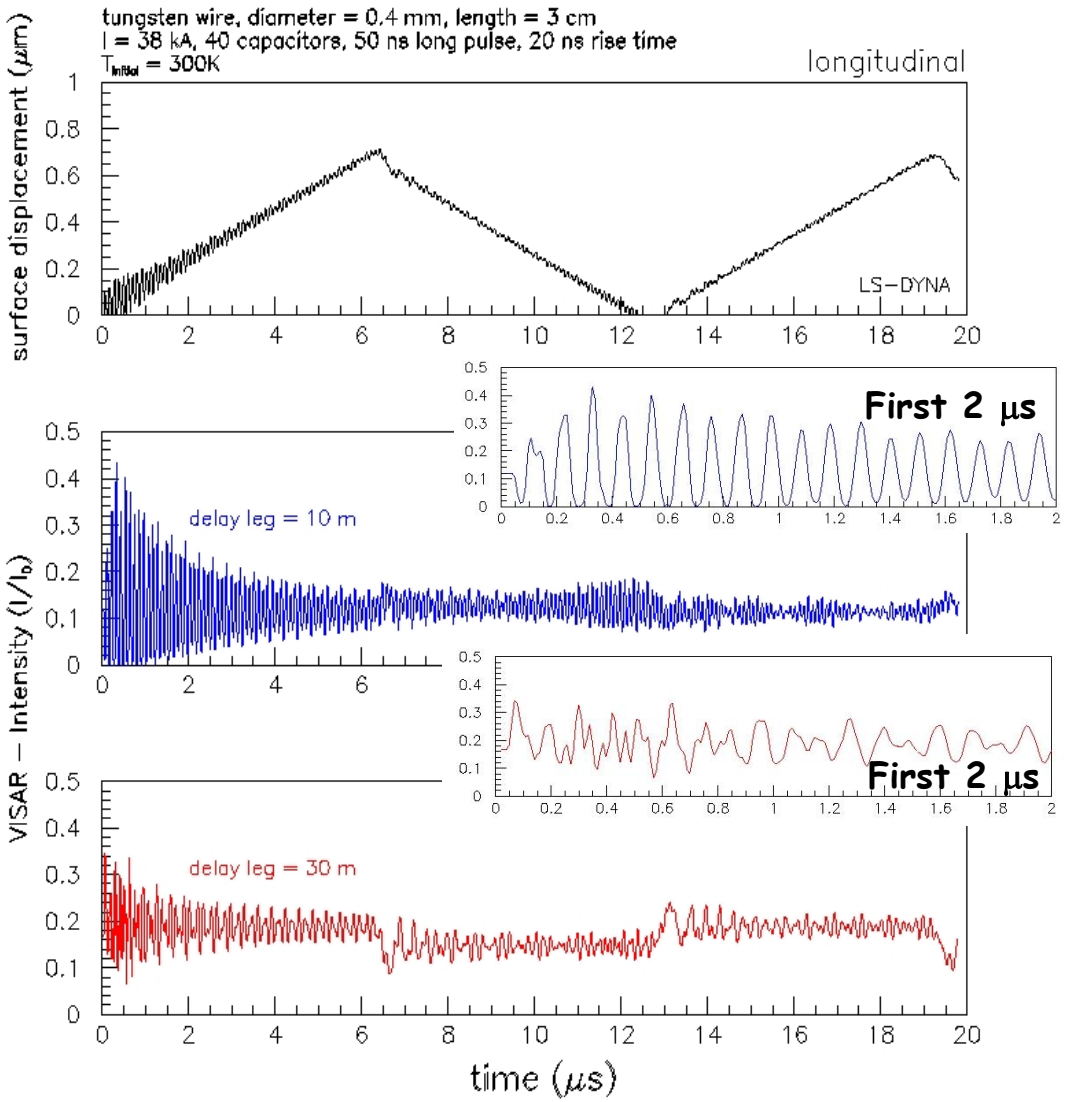
'40 capacitors' case - 0.4 mm diameter wire

end of wire





'Wishful thinking': Doubling the number of capacitors will give us a beautiful signal for 0.4 mm diameter wire during the first 2 micro-s. And we could see it (even with the laser-beam spot size we have at the moment). But this 'huge number of circuits' scenario has its disadvantages…