Tungsten Wire & VISAR

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VISAR wire tests – Standard approach

**Schematic circuit diagram of the wire test equipment**

- Test wire, 0.5 mm $\Phi$
- Vacuum chamber, $2 \times 10^{-7} - 1 \times 10^{-6}$ mbar
- Coaxial wires

**Pulsed Power Supply.**
- 0-60 kV; 0-10000 A
- 100 ns rise and fall time
- 800 ns flat top
- Repetition rate 50 Hz or sub-multiples of 2

**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?**

**Results of calculations -> following pages**
Results

Radial displacements

VISAR signal:
- flatline
(for room and high temperature; for 10m and 30m delay-leg)

Conclusion: We won't see anything here
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.
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.
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...**
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).
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.
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...
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...
Practically no signal for 20 capacitors but may look promising if we add more circuits (see slide 13)
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.
'40 capacitors' case - 0.4 mm diameter wire

VISAR wire tests - Alternative approach

end of wire

'thoughful 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...