

**Creep test results for 50 μm
diameter wires made of tungsten
and tungsten + rhenium alloy.**

(preliminary results)

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1 Introduction.

For the creep we mean decrease of the wire tension with time while its length is fixed. Below are some results obtained during 2 years long test. We tested the creep of Au coated wires made of tungsten (W) and tungsten-rhenium (W + Re) alloys. All wires were manufactured by MELZ in Moscow. Some parameters of tested wires are shown in Table:

Material of wire	Diameter μm	Rupture limit grammes	Resistance Ohm/m
W(Au)	50	475	29
95%W + 5%Re(Au)	50	700	44
95%W + 5%Re(Au) (annealed)	50	375	44
80%W + 20%Re(Au)	50	400	98

2 Arrangement.

Two set-ups were used for the wire creep testing. The scheme of set-up 1 is shown in Fig 1. Set-up consists of two round getinax plates (paper/bakelite plastic) bounded with a thick steel tube. Thirty W wires with summarized initial tension 12,6 kg were stretched along the tube axis to form external surface of the reel. The wires were crimped in Cu tubes with internal diameter 0,25 mm and external one 1,0 mm. Special crimper with toothed working surfaces was used for the wire crimping.

The frequency of wire oscillation in magnet field was measured to determine wire tension. The reel was rotated around horizontal steel rod to place a wire near a magnet.

The temperature of the steel tube and that of air near the wires were measured to provide the correction of wire oscillation frequency for temperature effect. This correction wasn't perfect what caused the biggest part of wire tension error.

The scheme of set-up 2 is about the same, but it was equipped with plexiglass plates instead getinax ones. A set of W wires with low tensions and all W + Re wires were mounted here with summarized initial tension 13,3 kg.

3 W wires creep test results.

The creep for a set of W wires with different initial tensions is shown in Fig 2. Linear extrapolation of experimental results to 15 years time was made using last 8 experimental points.

The creep for W wires exposed to pretension 450 g during 1,5 and 25 minutes is shown in Fig 3, 4 and 5.

We were surprised with a very big creep for the wires with lower tensions which became noticeable at the sixth month after beginning of the test. To clear the situation up we arranged the set-up 2 where a set of W wires with low tensions was mounted. The creep for these wires is shown in Fig 6, 7.

The creep for 2 years period (2 years creep) and extrapolation to 15 years period (15 years creep) for all W wire sets are shown in Fig 8 and Fig 9. It is clear that results for the of low wire tension region measured at set-up 2 are not consistent with previous ones. There is some supplementary source of the creep which gives a contribution in the measured value. This contribution is most prominent for the wires with the smallest tension. Only two elements can be suspected as the possible source. The first one is the copper tube used for the wire crimping. Plastic stressed under this tube can creep and wire can release from the place of crimping. But these effects must grow with the wire tension what we don't see yet. The second candidate is plastic plate which can creep if stressed or contract because of water or something else evaporation . In this case effect will be most prominent for the wires with the smallest tension what we see.

We tried to correct the results inducing some value of contraction for the plastic plates. The 2 years creep corrected with 170 μm contraction for the getinax plates and 20 μm for the plexiglass ones is shown in Fig 10 .The picture improved noticeably . The 15 years creep corrected with 250 μm contraction for the getinax plates and 20 μm for the plexiglass ones is shown in Fig 11.

We will use these correction though we haven't any confirm for used figures.

Results:

- **The two years creep is significant (10% and more) for the initial wire tension higher then 250 g.**
- **Usage of pretension allows to decrease the 2 years creep, 450 g pretension during 5 min allows to apply additional 100 g of the initial wire tension with the same result for the creep.**
- **The creep for the time between 2 years and 15 years is small enough (not more than 1÷2%) for the initial wire tension up to 400 g and the influence of pretension isn't noticeable.**

4 W + Re wires creep test results.

The creep for a set of wires made of 95% W + 5% Re alloy with different initial tensions is shown in Fig 12. The two years creep for these wires and that for two wires with pretension 600 g during 1 min and 5 min are shown in Fig 13. The two years creep for annealed wires made of the same alloy is shown in this figure too. The 15 years creep is shown in Fig 14. The same values corrected for 20 μm plexiglass contraction are shown in Fig 15 and 16.

Results for wires made of 80 % W + 20 % Re alloy are shown in Fig 17, 18. Two sets of such wires were tested: without pretension and with pretension 350 g during 5 min. Result corrected for 20 μ m plexiglass contraction are shown in Fig 19, 20.

Results:

- Increasing of Re admixture in W + Re alloy leads to the creep decreasing. For 80 % W + 20 % Re alloy there is no evidence for creep up to 300 g initial wire tension.
- The two years creep for W + Re wires is significantly less than the one for W wires.
- Usage of the pretension decreases 2 years creep noticeably.
- Thermal treatment after manufacturing may "spoil" the wire: the 2 years creep grows, the rupture limit falls.
- The creep for the time between 2 and 15 years is small (not more 1%) for the initial wire tensions up to the rupture limit and the influence of pretension isn't noticeable.

5 Conclusion.

- The W wire have the significant (more 10 %) 2 years creep for the initial tension higher than 250 g. Acceptable value of the tension can be increased up to 350 g with help of the pretension. Long term creep (from 2 to 15 years) doesn't exceed 1 ÷ 2 % for the initial wire tensions up to 400 g.
- The best creep properties shows wire made of 95 % W + 5 % Re alloy. This wire was checked with initial tension up to 639 g, the 2 years creep for this tension doesn't exceed 5 % and can be lowered with pretension usage, the long term creep (from 2 to 15 years) doesn't exceed 1 %.
- There is some supplementary source which can give significant contribution in the measured value of the creep. A probable candidates for this are plastic plates which support stretched wires. Mechanism of the effect isn't clear yet, but a signal for careful examination of long term stability of the wire fixation in the end plug of MDT is evident.

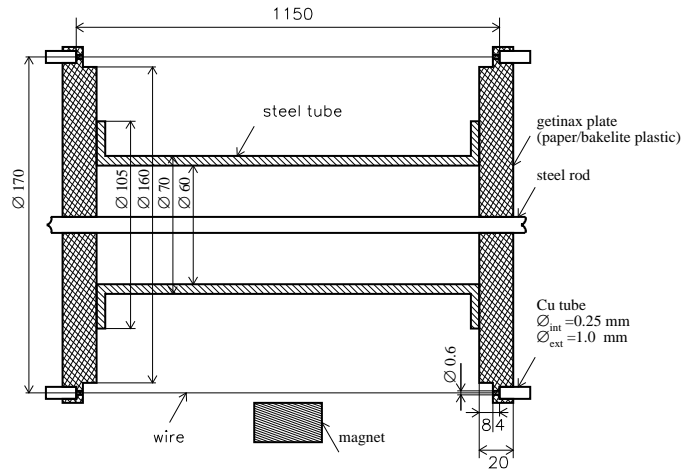


Figure 1:

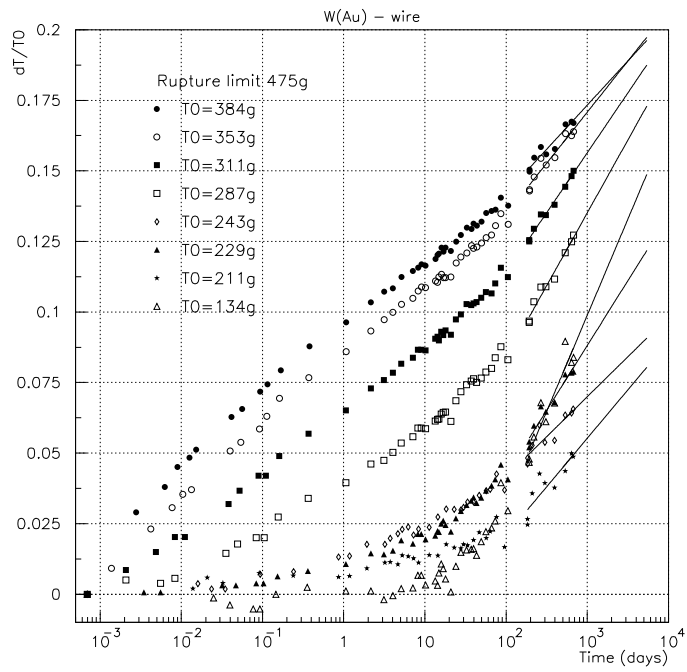


Figure 2:

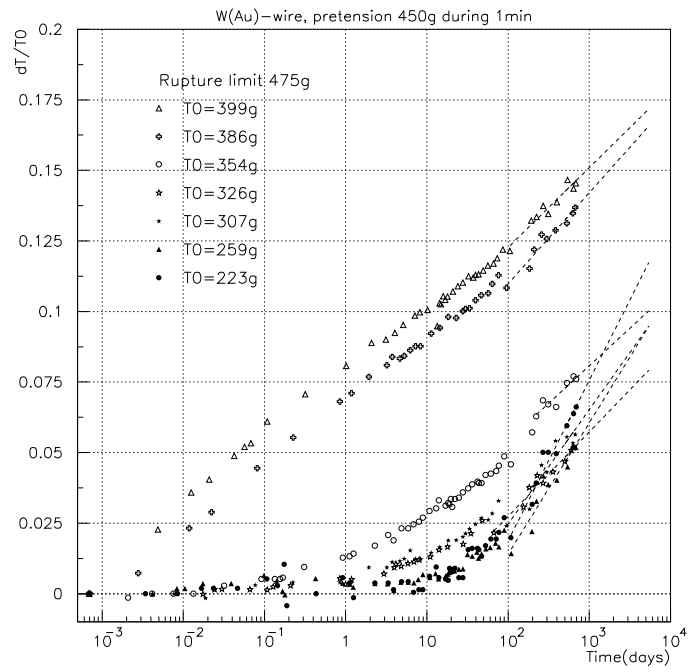


Figure 3:

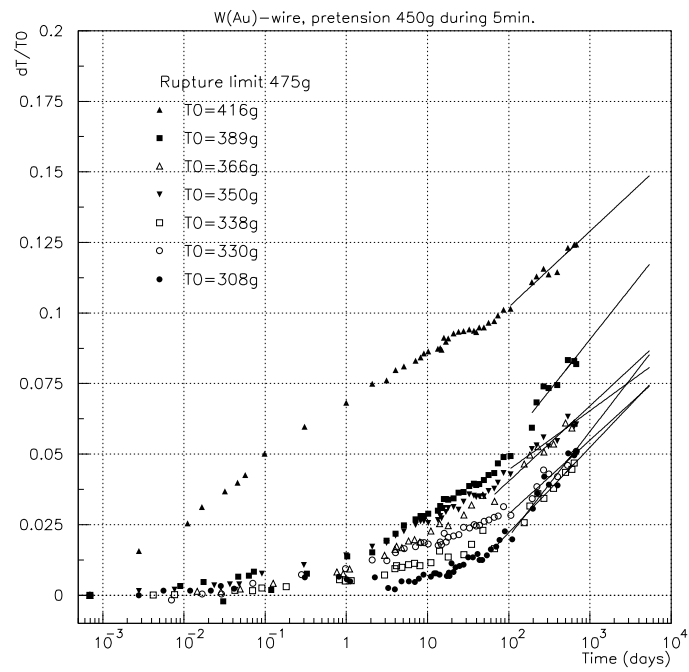


Figure 4:

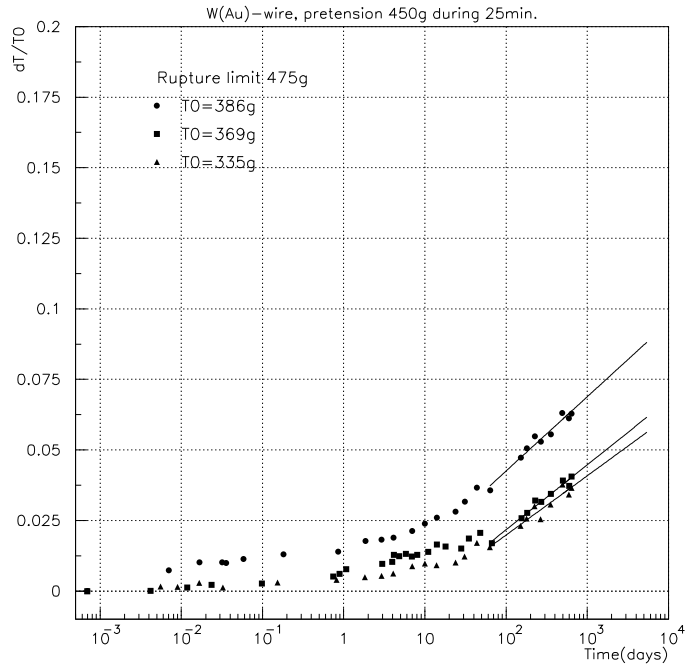


Figure 5:

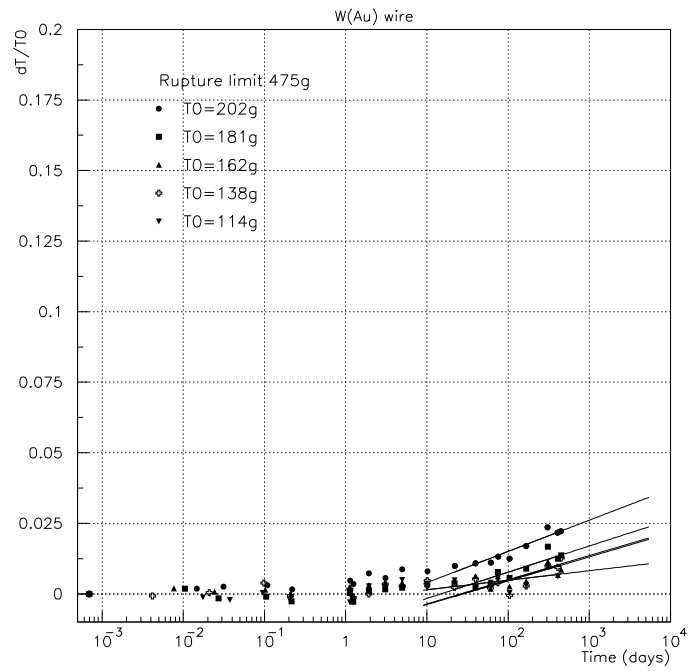


Figure 6:

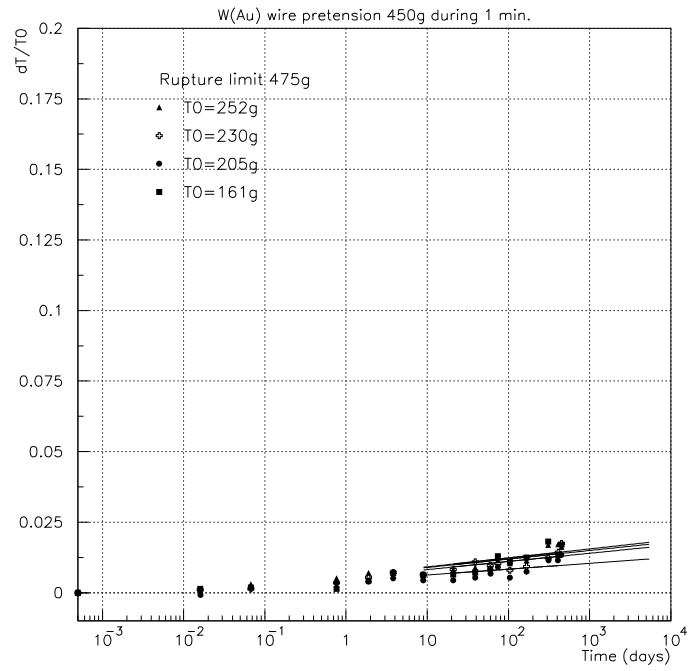


Figure 7:

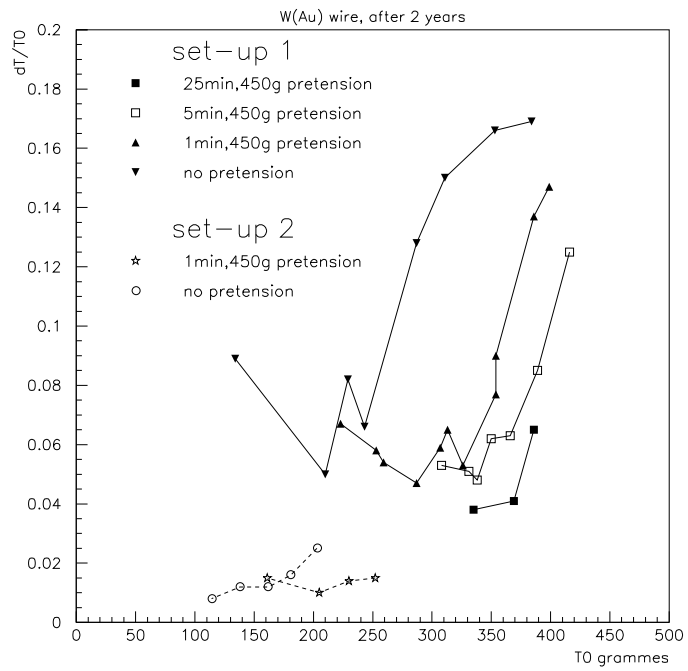


Figure 8:

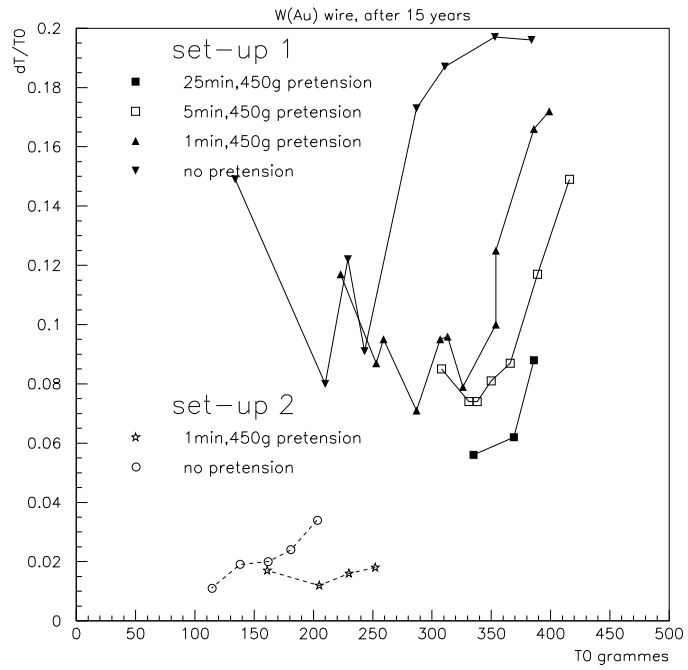


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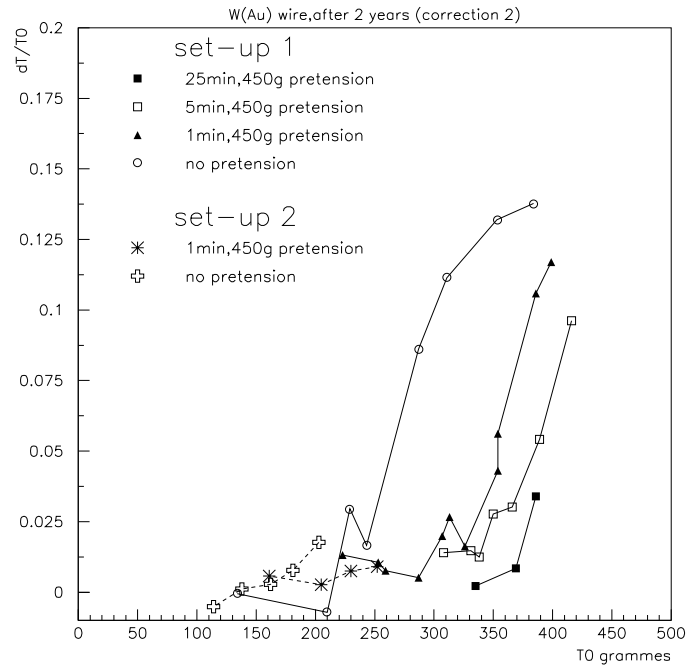


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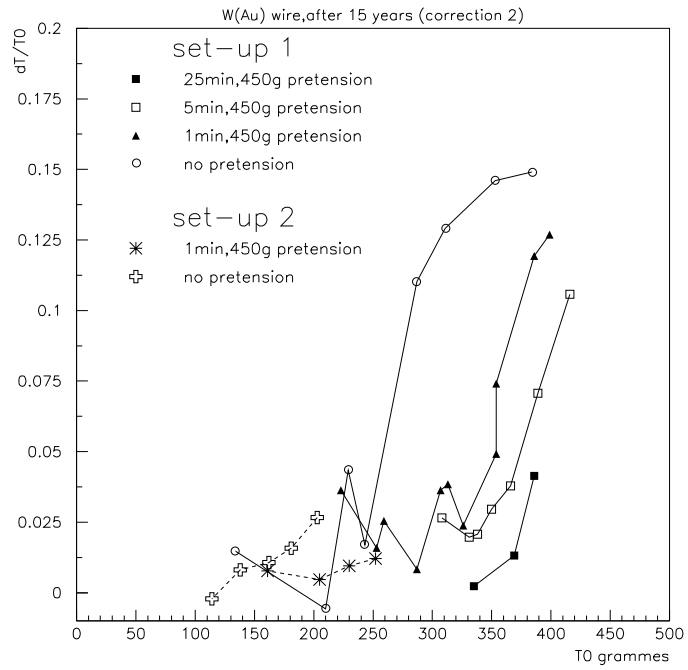


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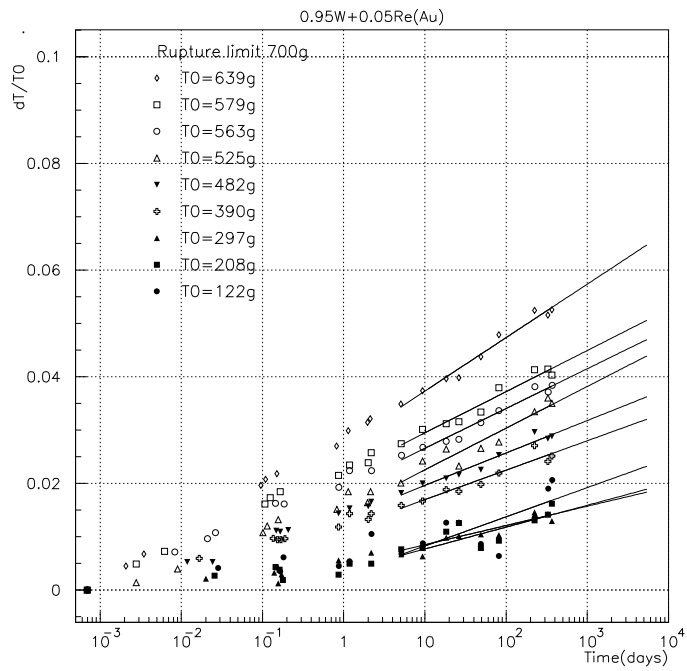


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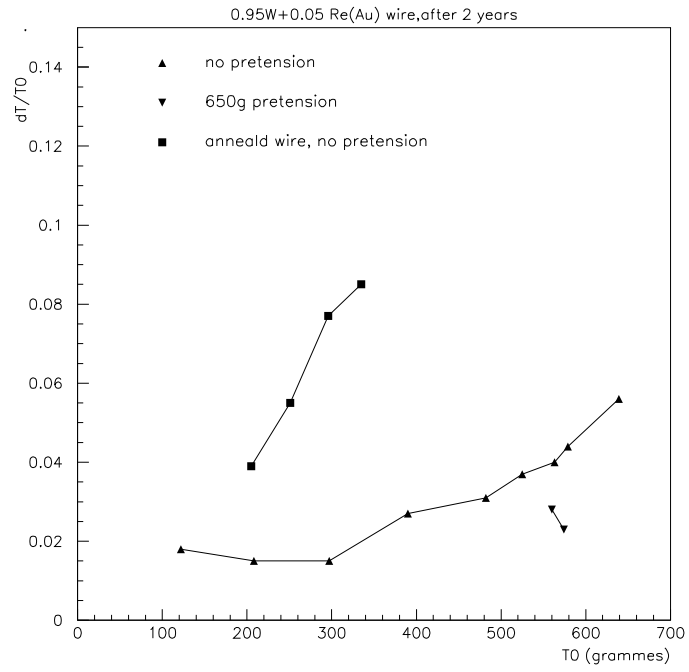


Figure 13:

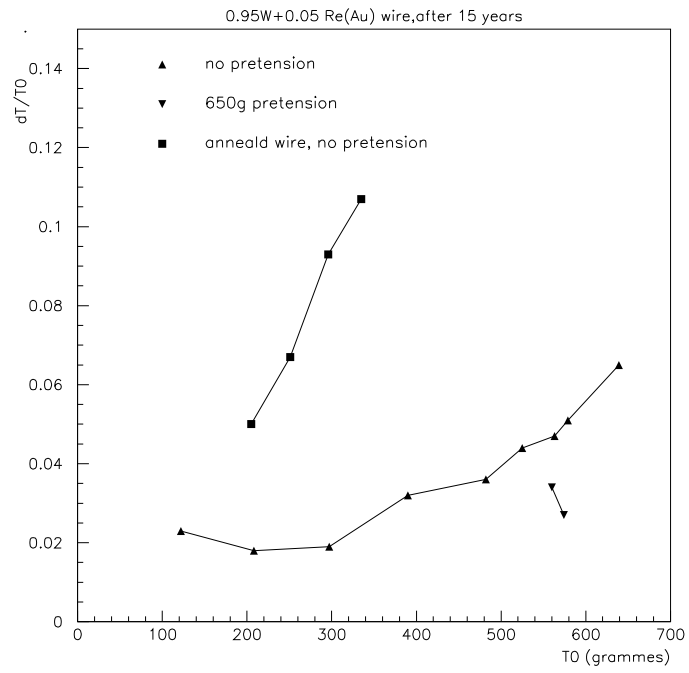


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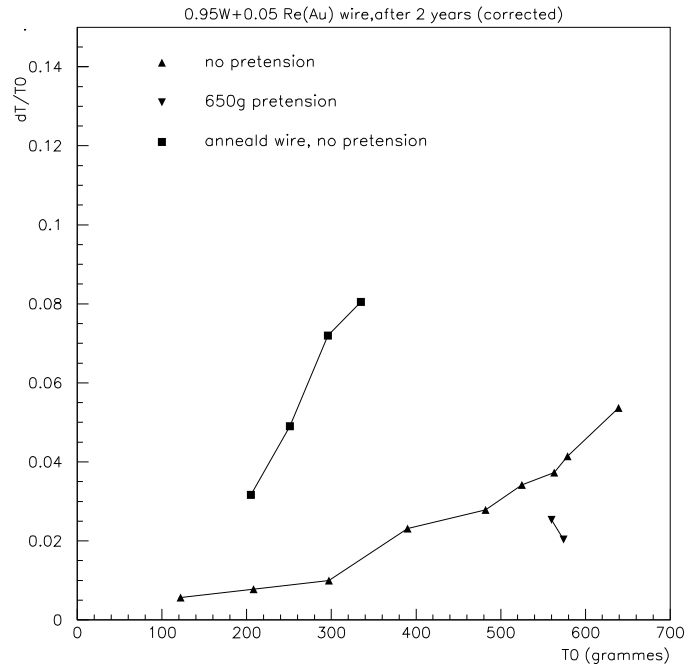


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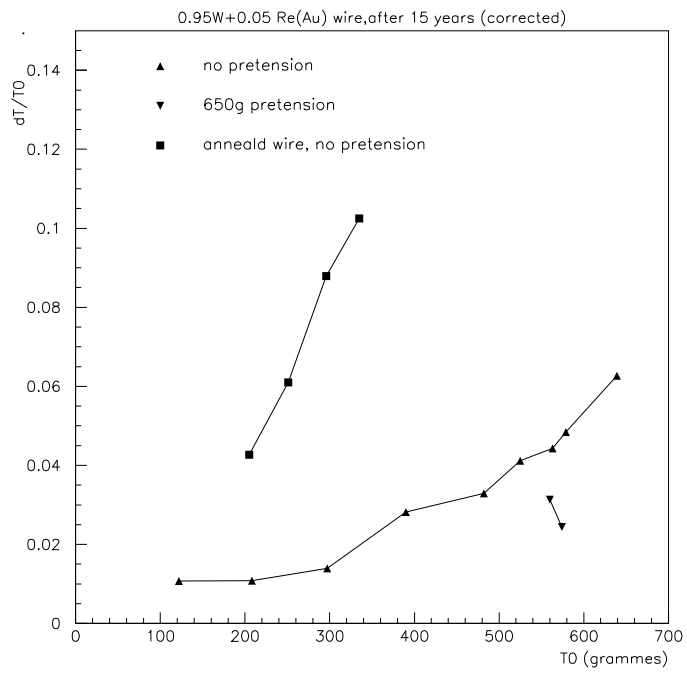


Figure 16:

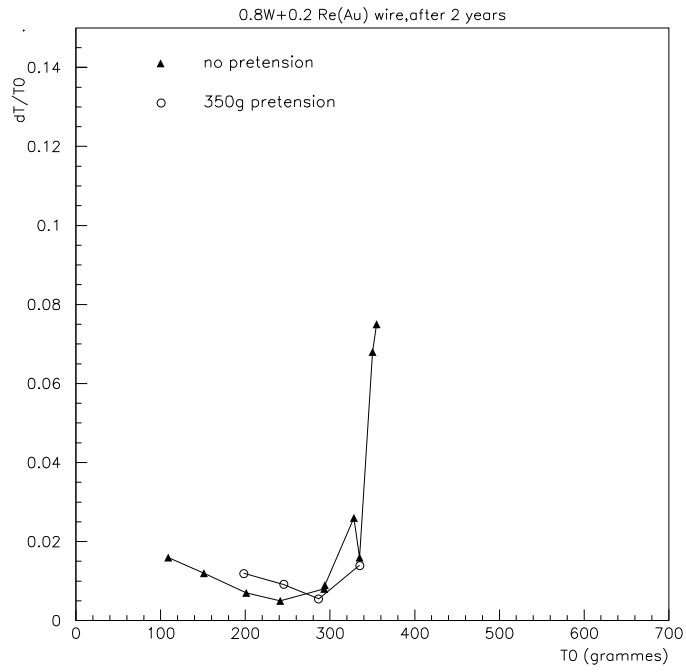


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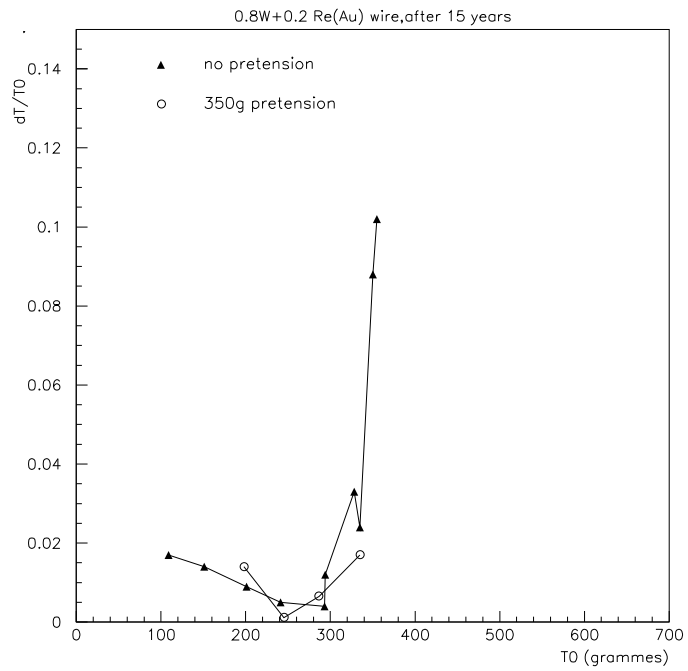


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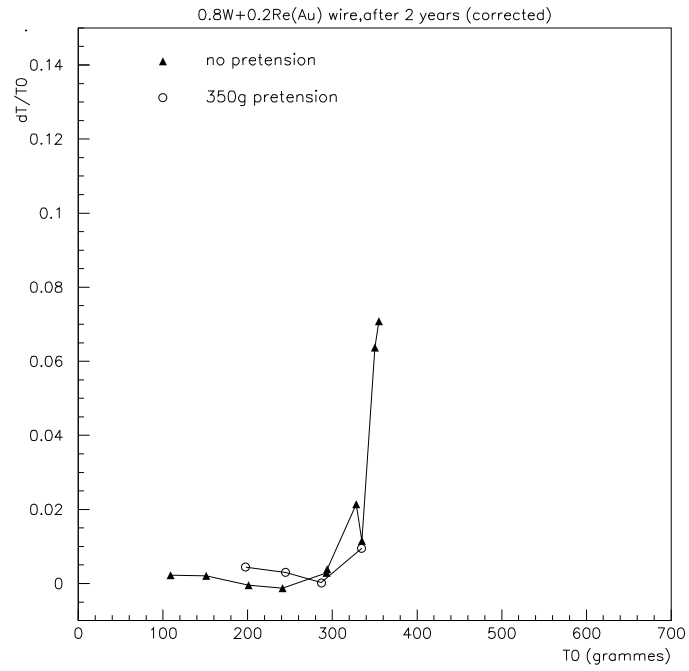


Figure 19:

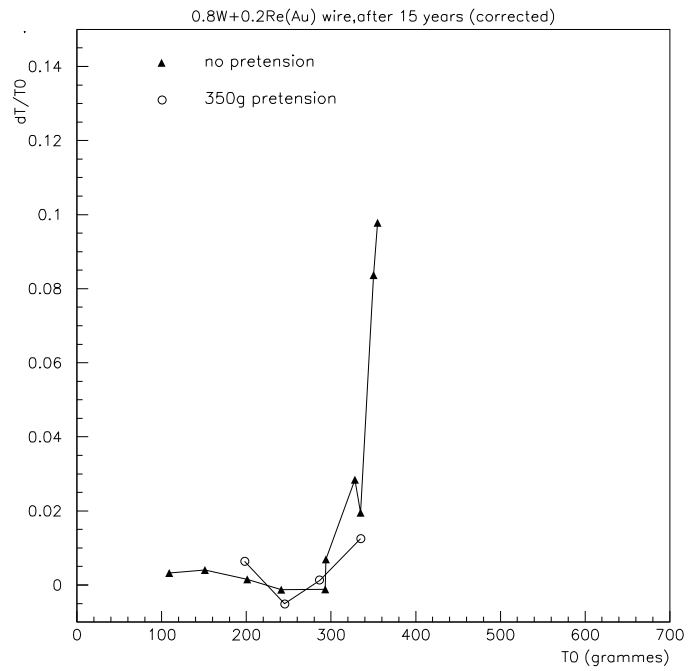


Figure 20: