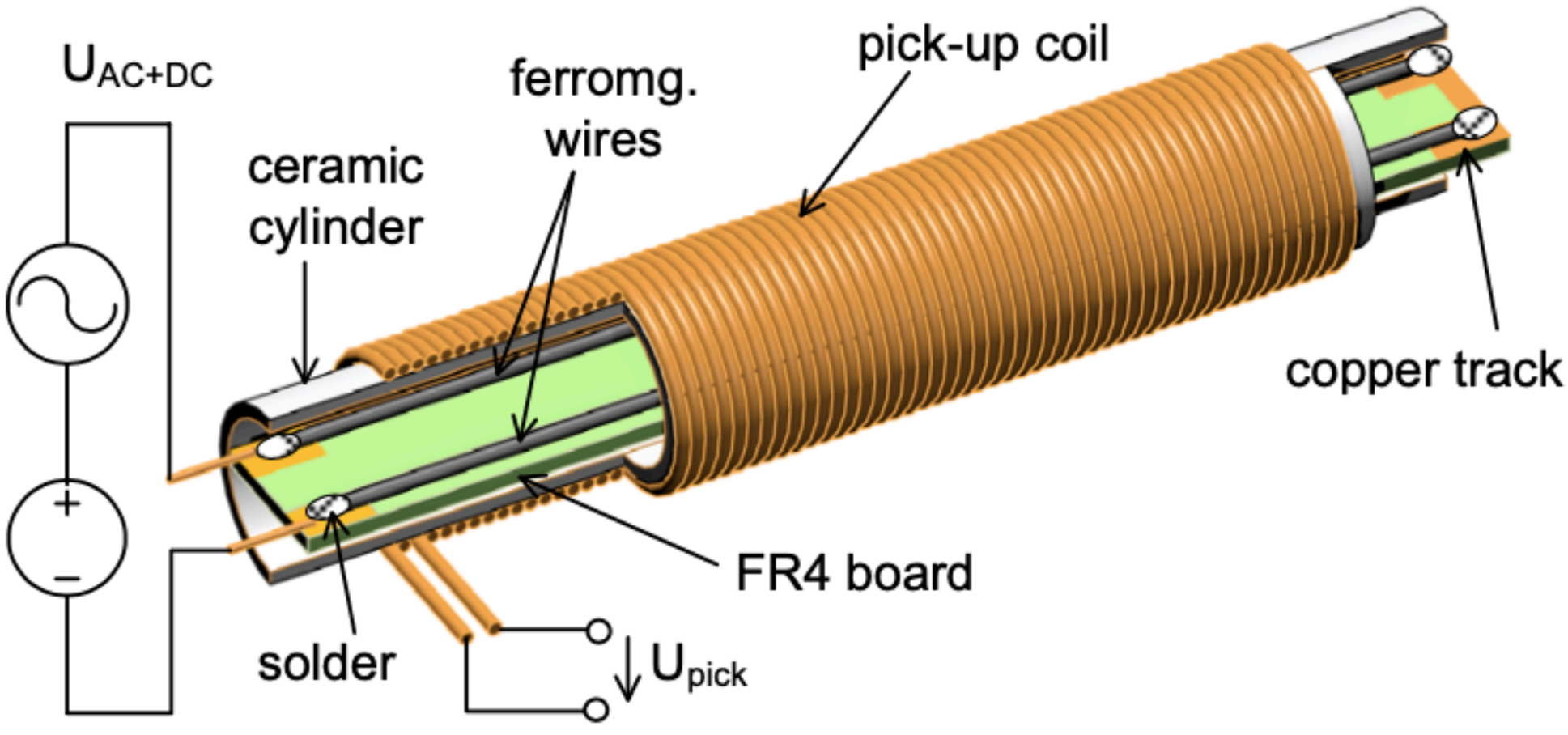
A better composition for magnetic microwires? Playing with cobalt and iron.

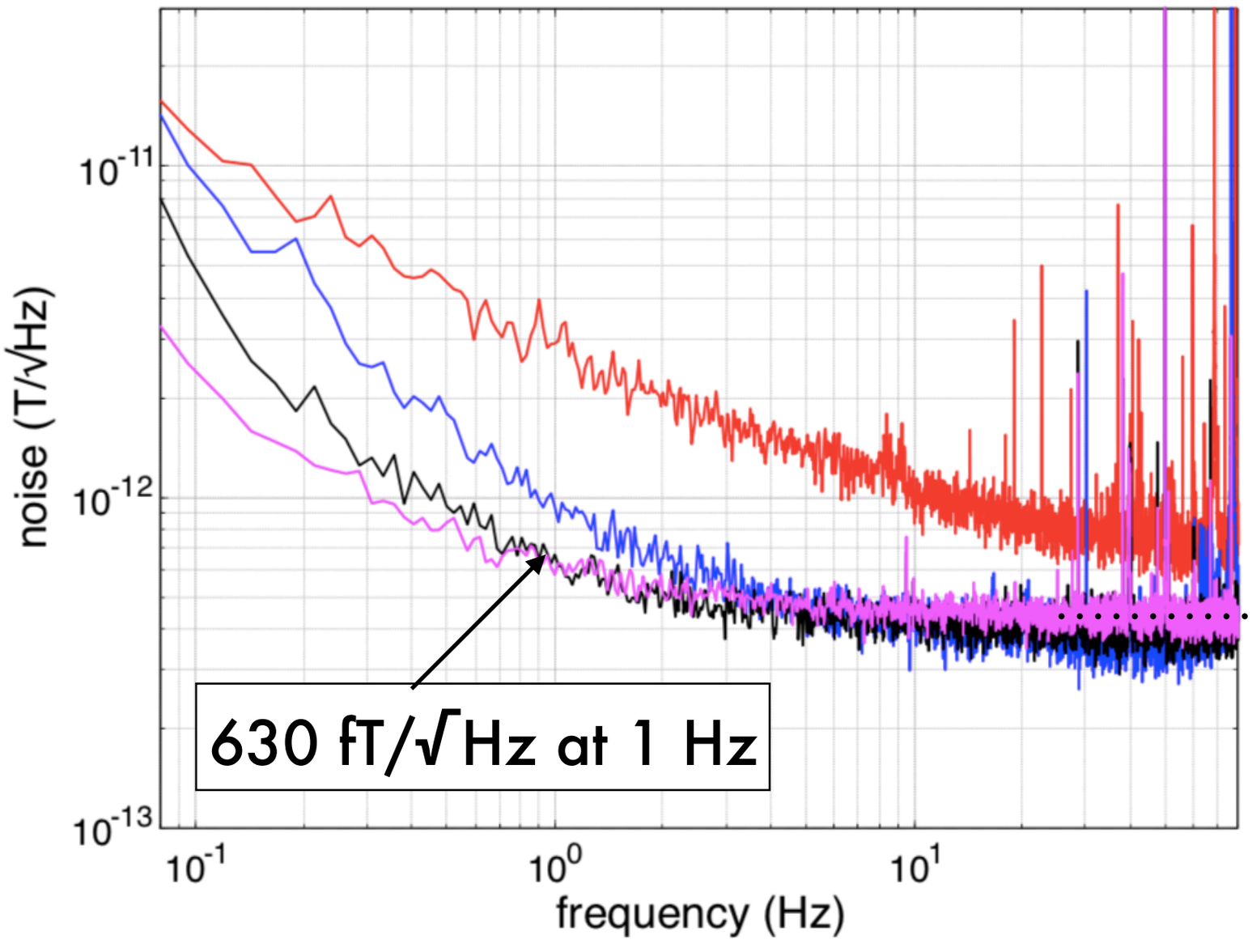
M. Butta

Department of Measurement
Faculty of Electrical Engineering

Our great sensor



The noise



annealing time

as cast

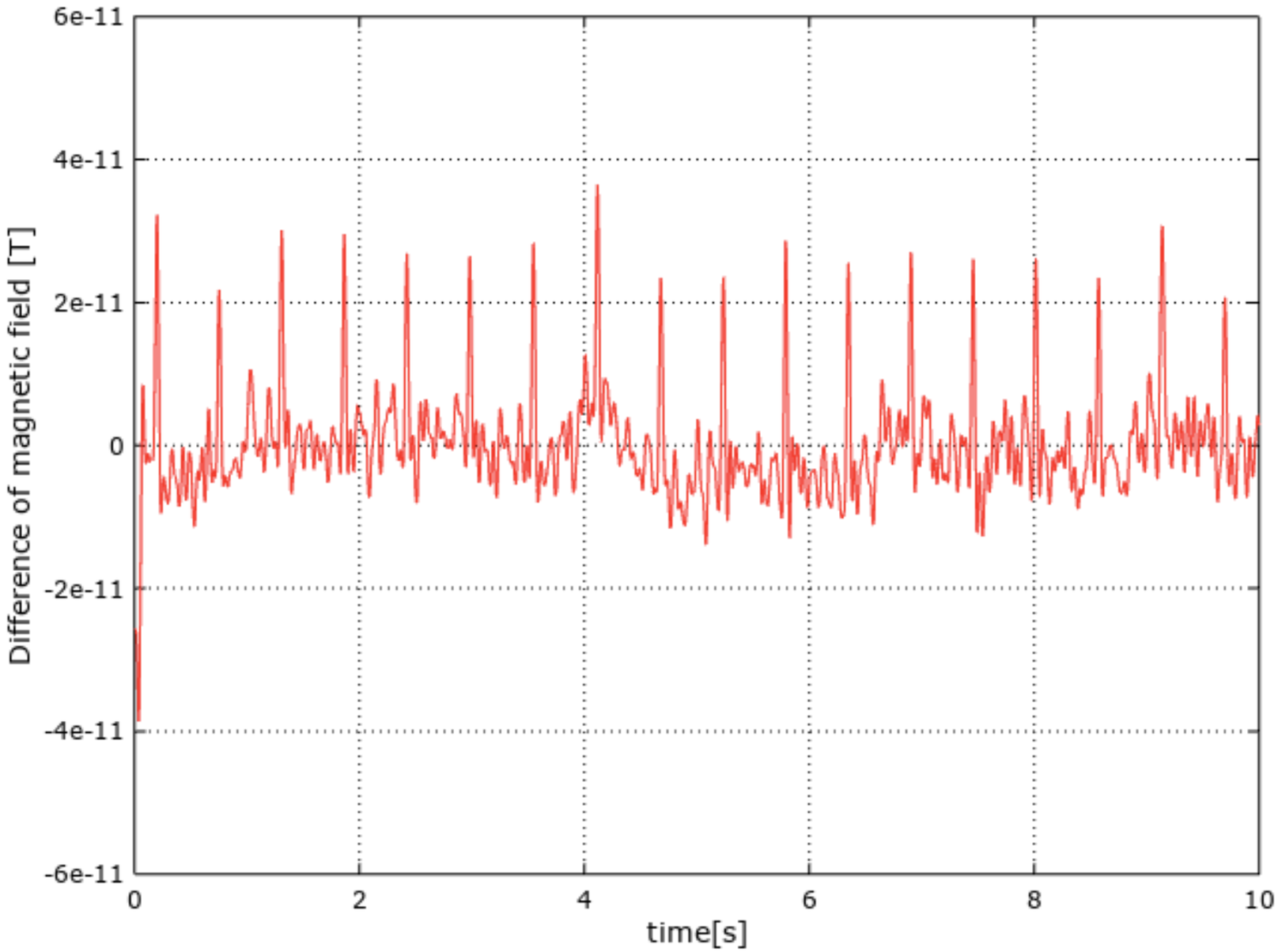
1 minute

11 minutes

21 minutes

410 fT/√Hz
noise floor

The magnetic field of my hearth



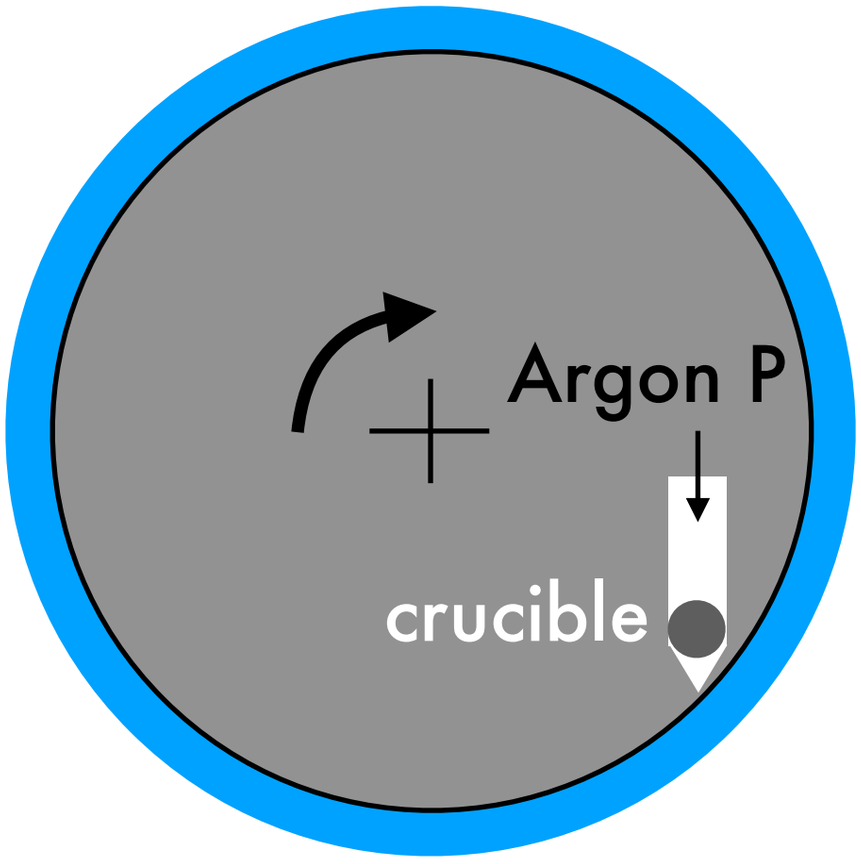
Still we have some noise. What is its origin?

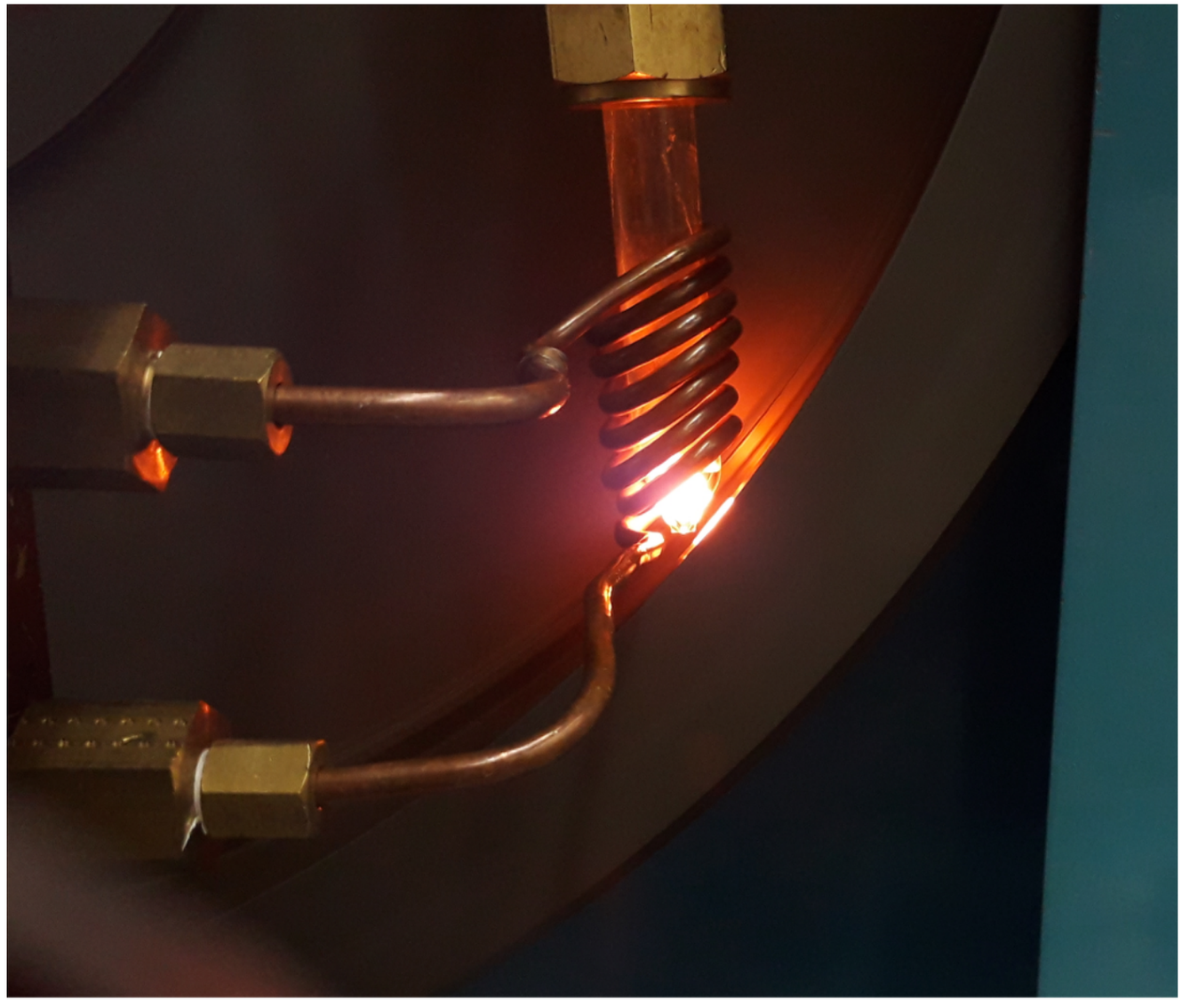
Magnetostriction?

$(Co_{0.94}Fe_{0.06})_{72.5}Si_{12.5}B_{15}$ $\lambda = 10^{-7}$

Vanishing magnetostriction is "vanishing enough"?

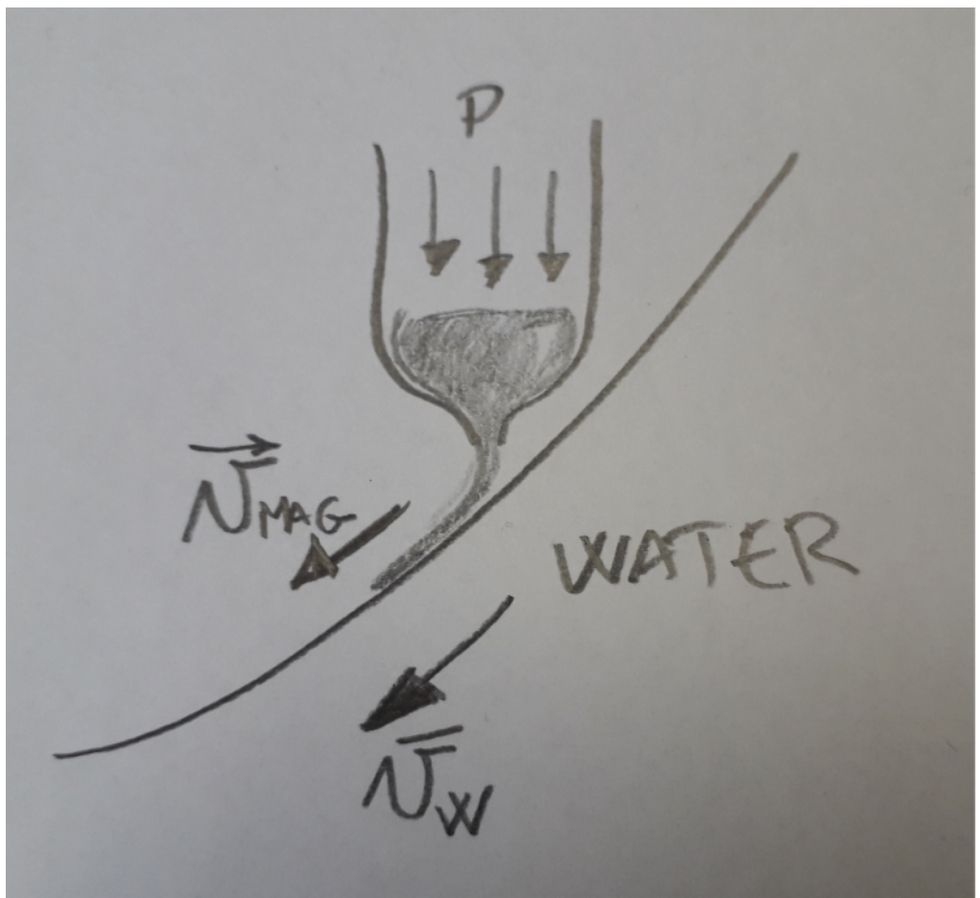
How amorphous wires are manufactured

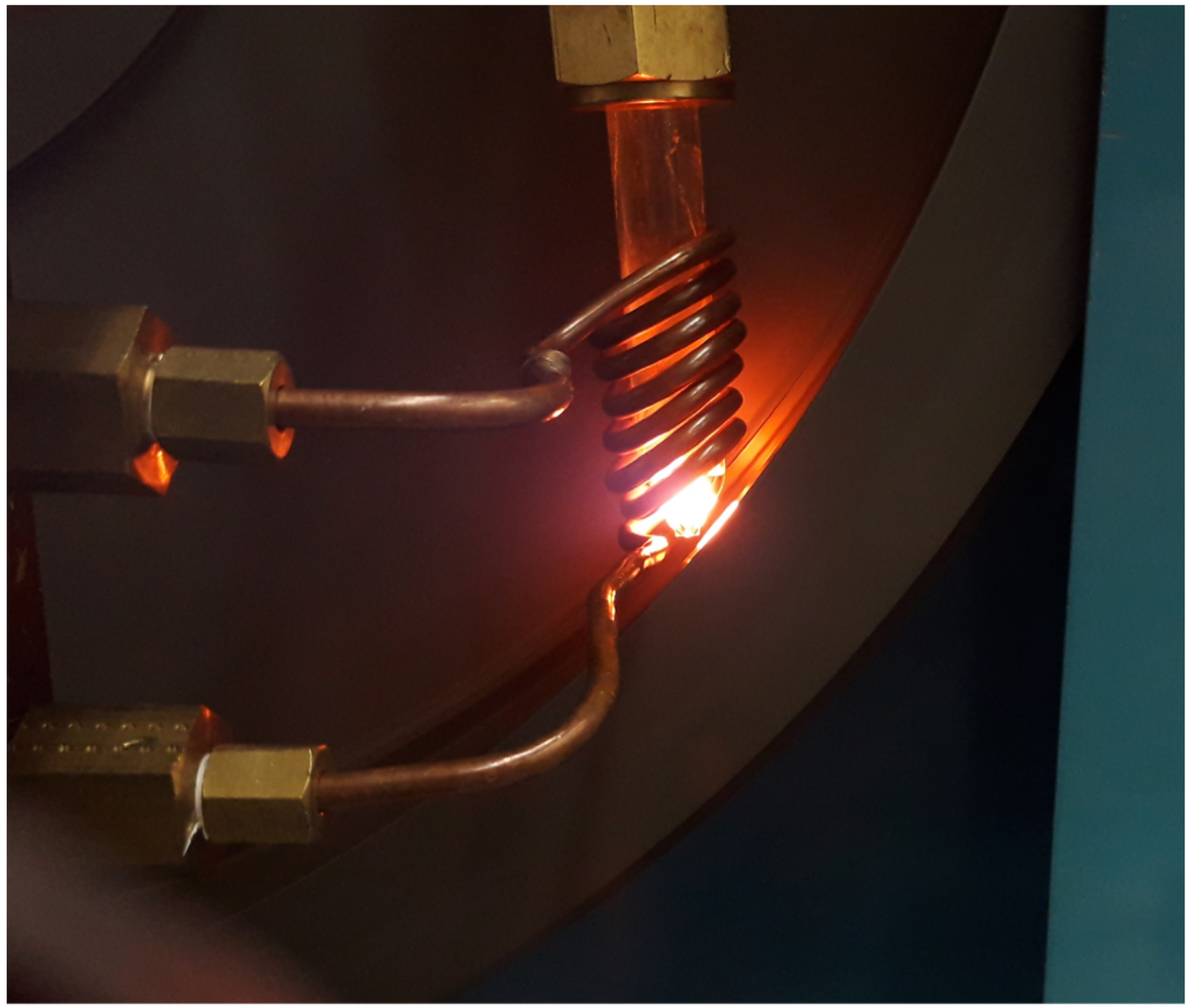




How amorphous wires are manufactured

Three parameter to set:
1) Temperature (—> viscosity)
2) Pressure of ejection
3) Speed of the wheel





How to change magnetostriction?

back to 1984...

Solid State Communications, Vol. 52, No. 7, pp. 701–703, 1984.
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Pergamon Press Ltd.

MAGNETOSTRICTION OF AMORPHOUS $(Co_{1-x}Fe_x)_{75}Si_{15}B_{10}$ RIBBONS $(0 \leqslant x \leqslant 0.12)$ AND ITS TEMPERATURE DEPENDENCE

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and

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(*Received* 11 *May* 1984 *by N.I. Meyer*)

How to change magnetostriction?

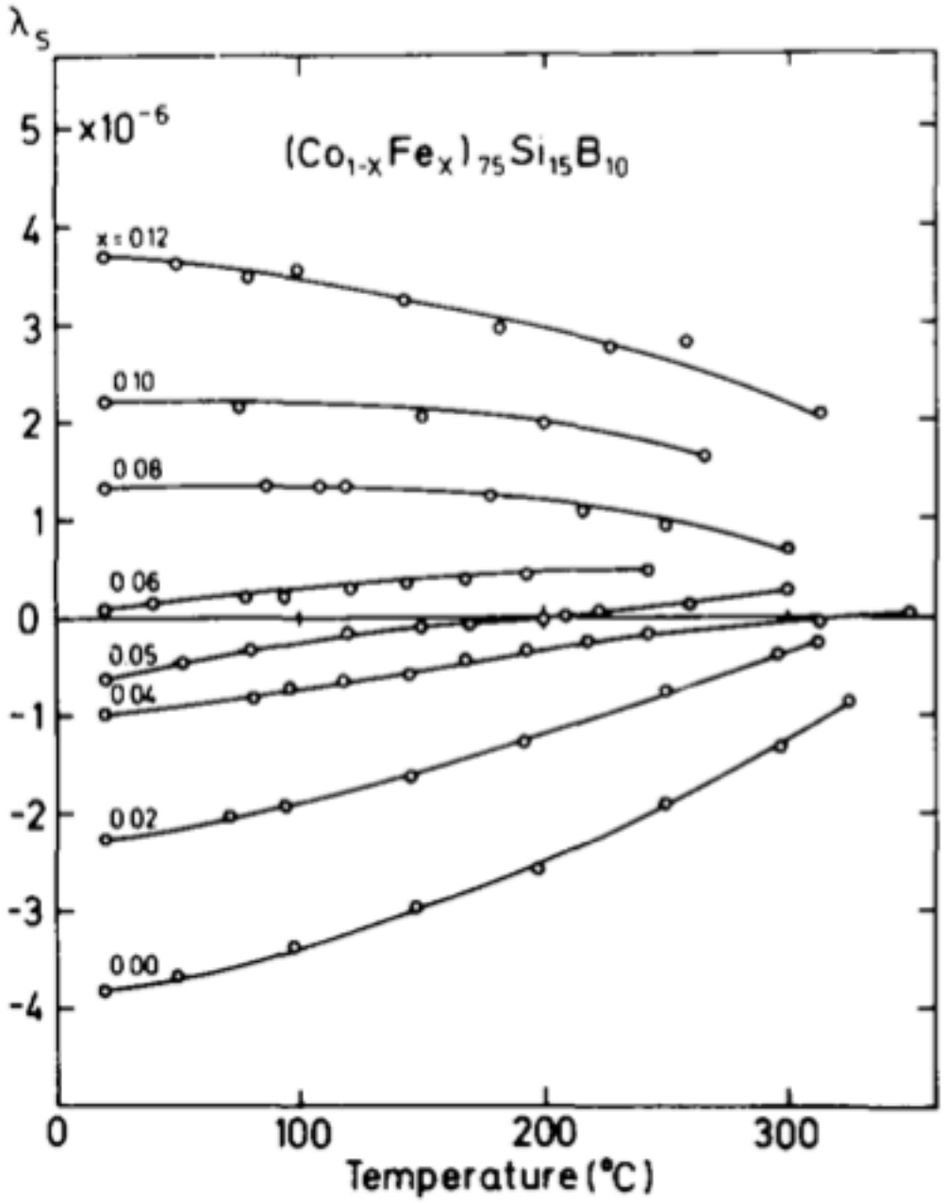


Fig. 1. Temperature dependence of magnetostriction coefficients λ_s. Compensation temperatures exist for $x = 0.04$ and 0.05.

$(Co_{1-x}Fe_x)_{75}Si_{15}B_{10}$

vs.

$(Co_{0.94}Fe_{0.06})_{72.5}Si_{12.5}B_{15}$

How to change magnetostriction?

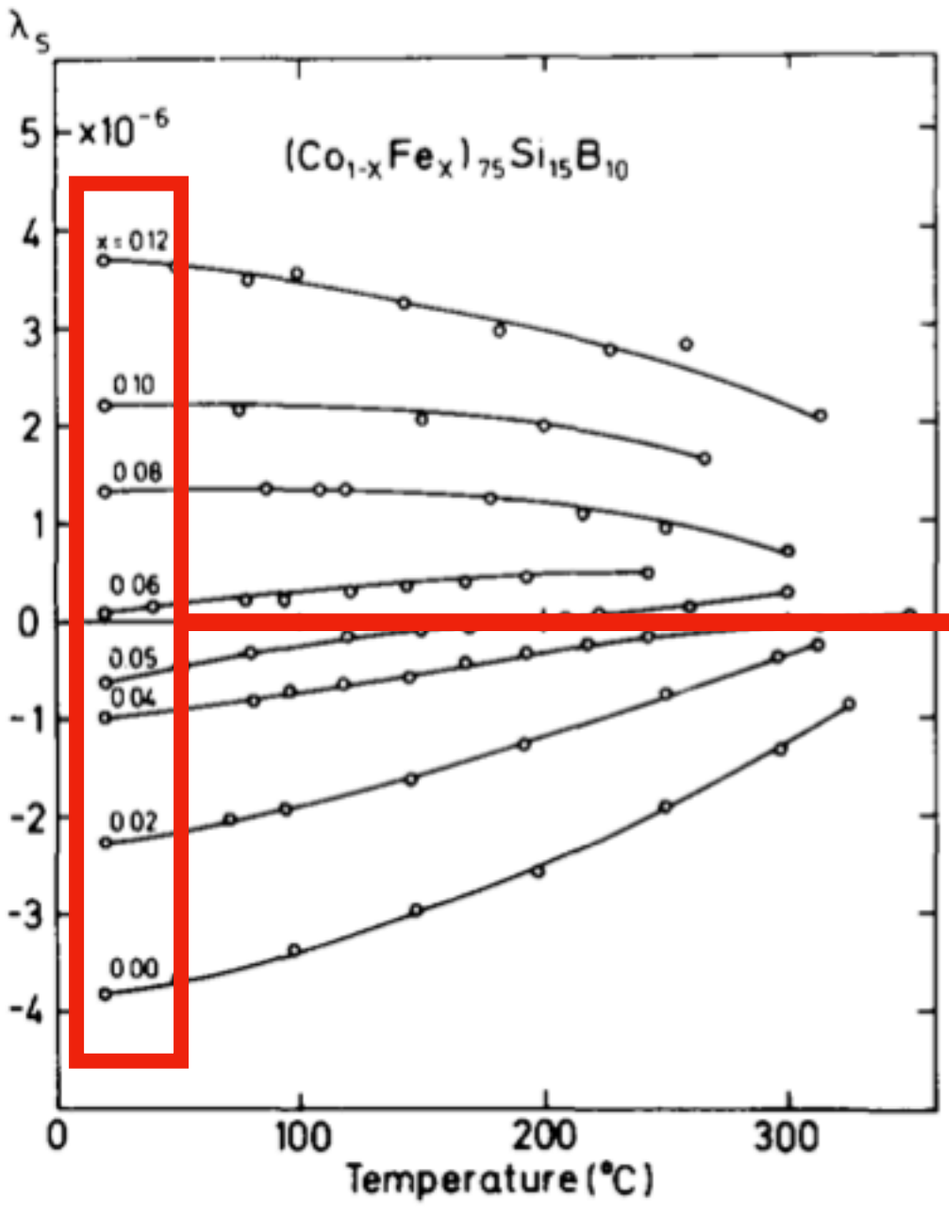


Fig. 1. Temperature dependence of magnetostriction coefficients λ_s. Compensation temperatures exist for $x = 0.04$ and 0.05.

Room temperature

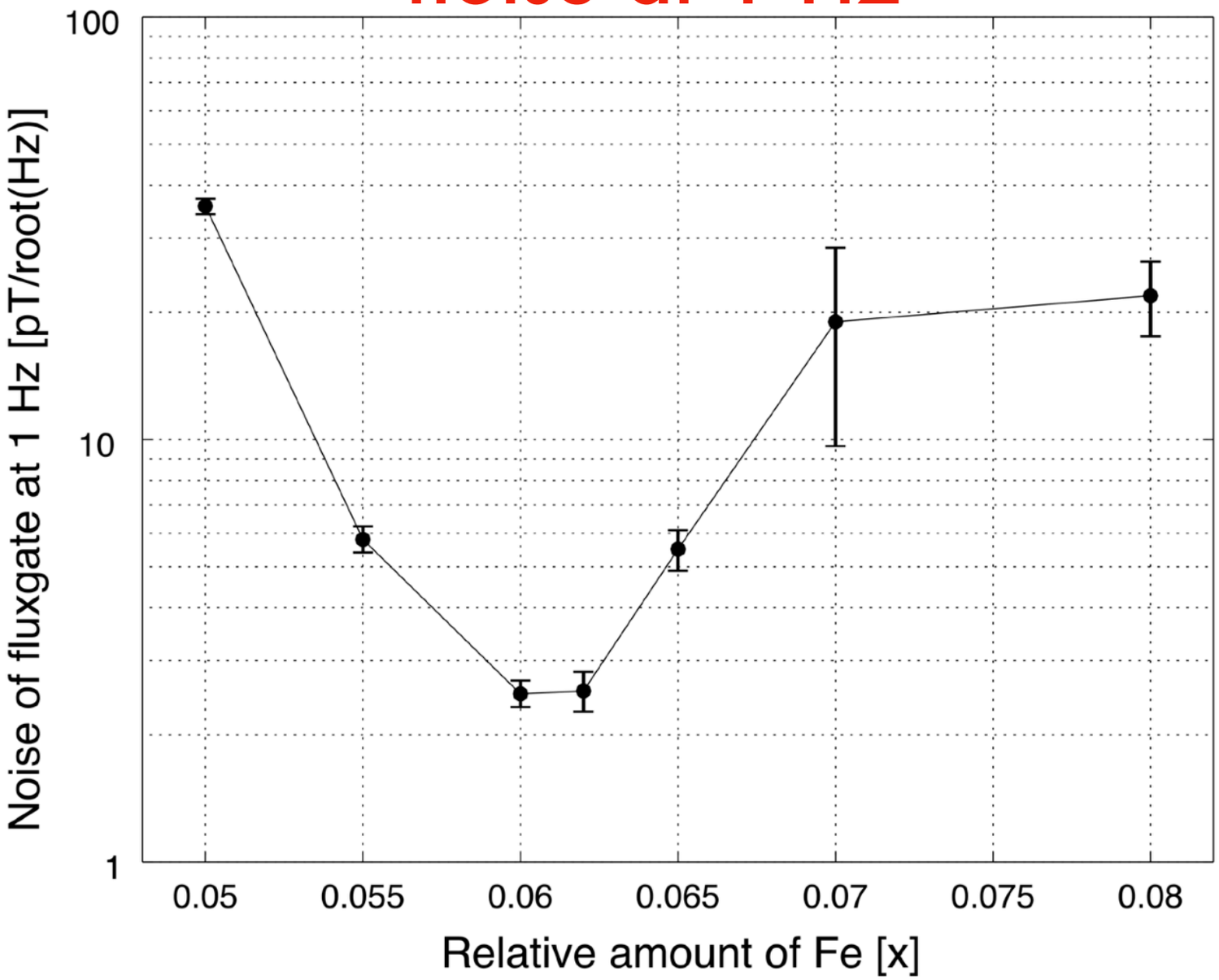
Magnetostriction is minimal at Fe=6%

Effect of magnetostriction on the noise of the fluxgate

- we casted wires with different composition:
  5%, 5.5%, 6%,6.2%, 6.5 %, 7% and 8%
- 3 fluxgates for each composition
- each sensor produced by wires from a different casting
- 2 wires for each sensor

Effect of magnetostriction on the noise of the fluxgate

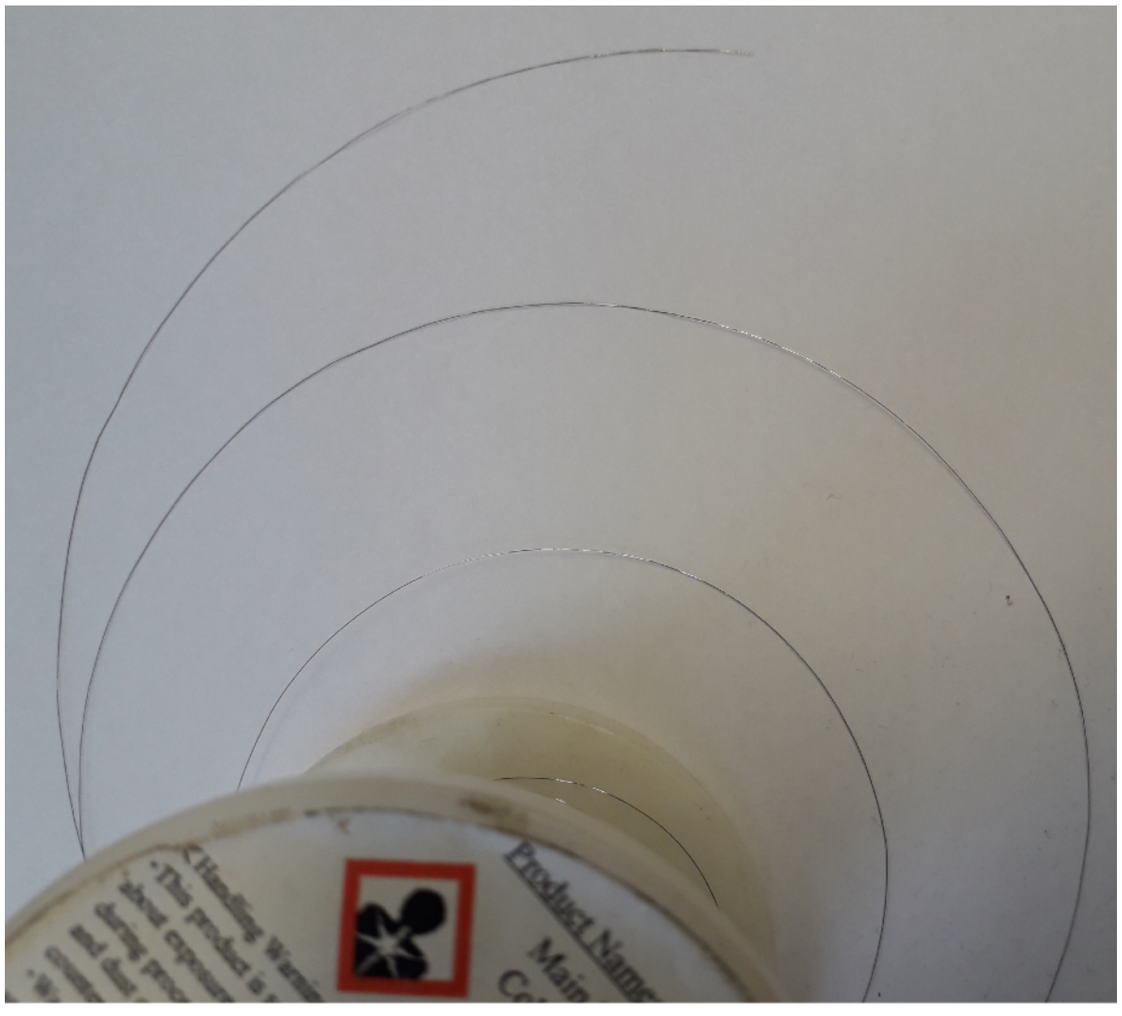
noise at 1 Hz

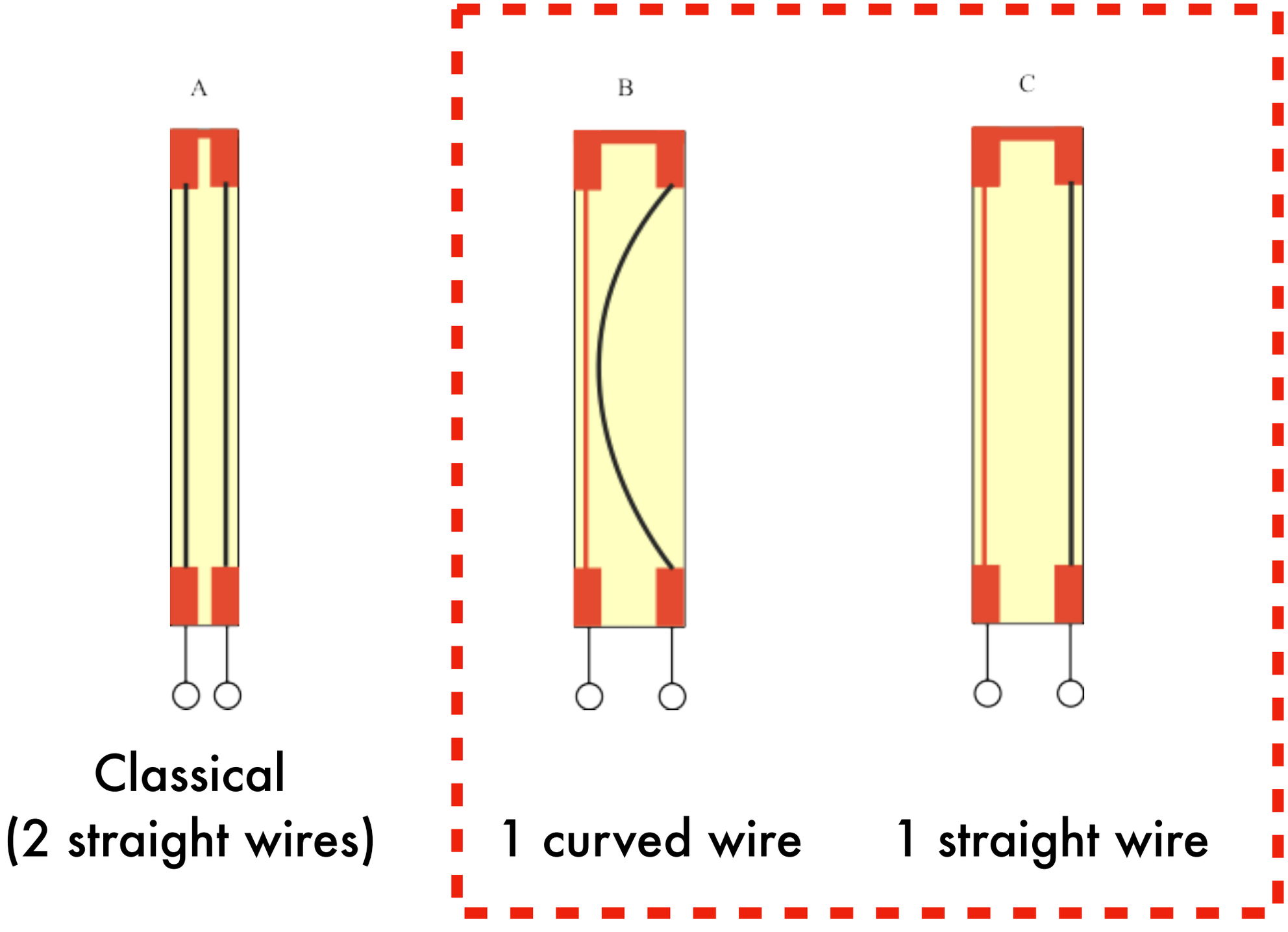


If you cannot decrease the magnetostriction...
... decrease the mechanical stress!

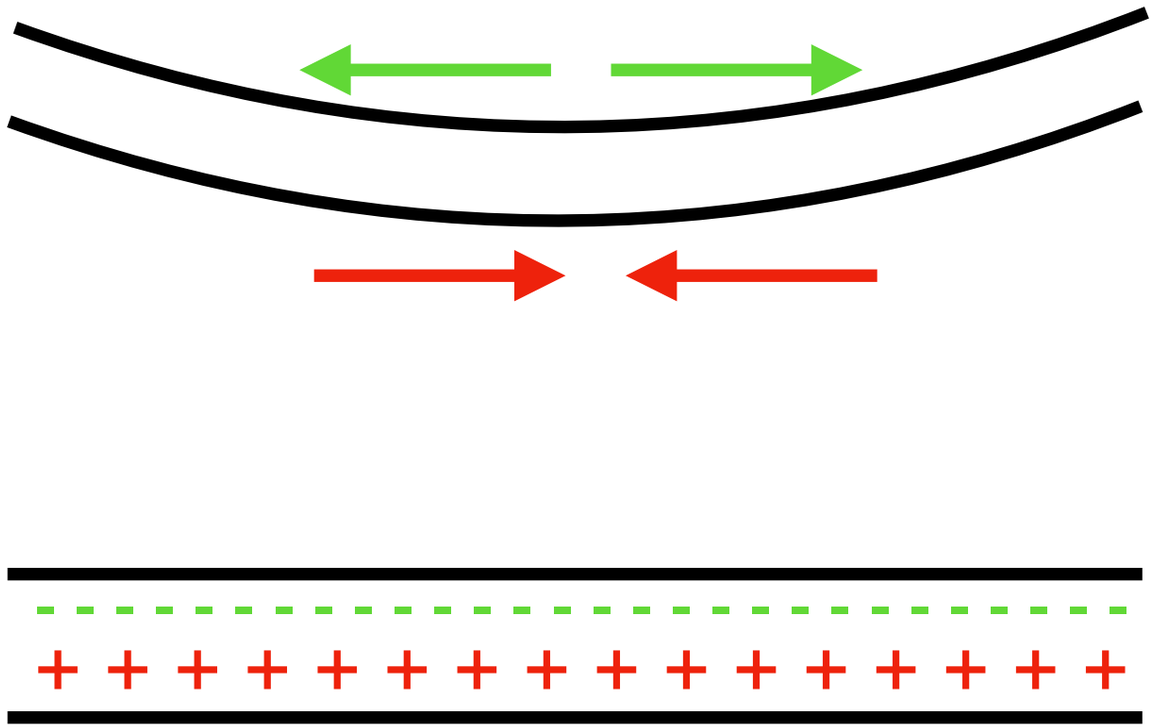
Wires are naturally curved
(of course, they have been casted on a wheel)

but they are bent to be straight when mounted on the sensor's holds

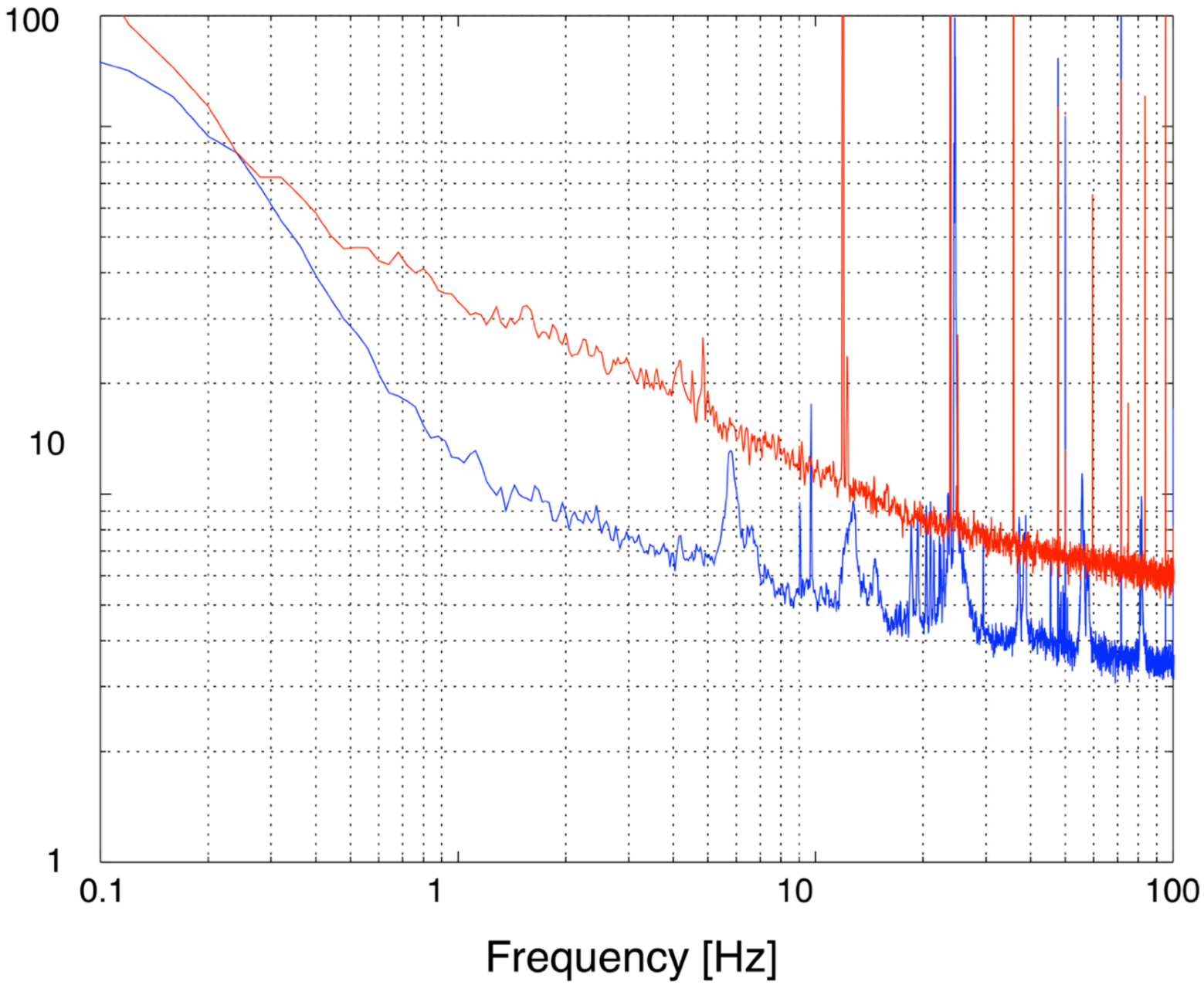



A
B
C
Classical
(2 straight wires)
1 curved wire
1 straight wire

Bending means opposite mechanical stress to the wire



The noise changes if magnetostriction is non-zero. Eg. Fe=5.5%



Blue: curved
Red: straight

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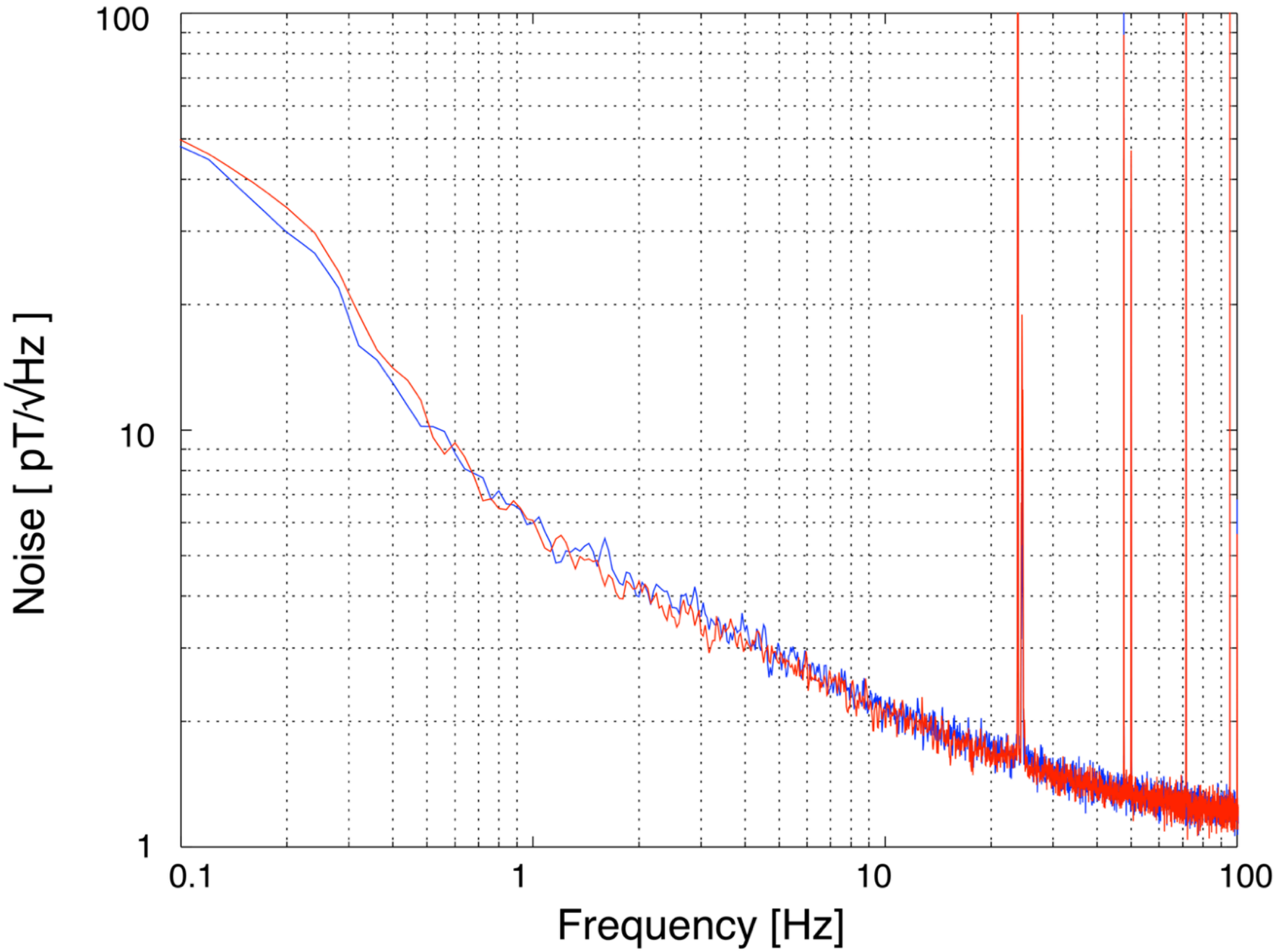


Blue: curved

Red: straight

The noise is IDENTICAL

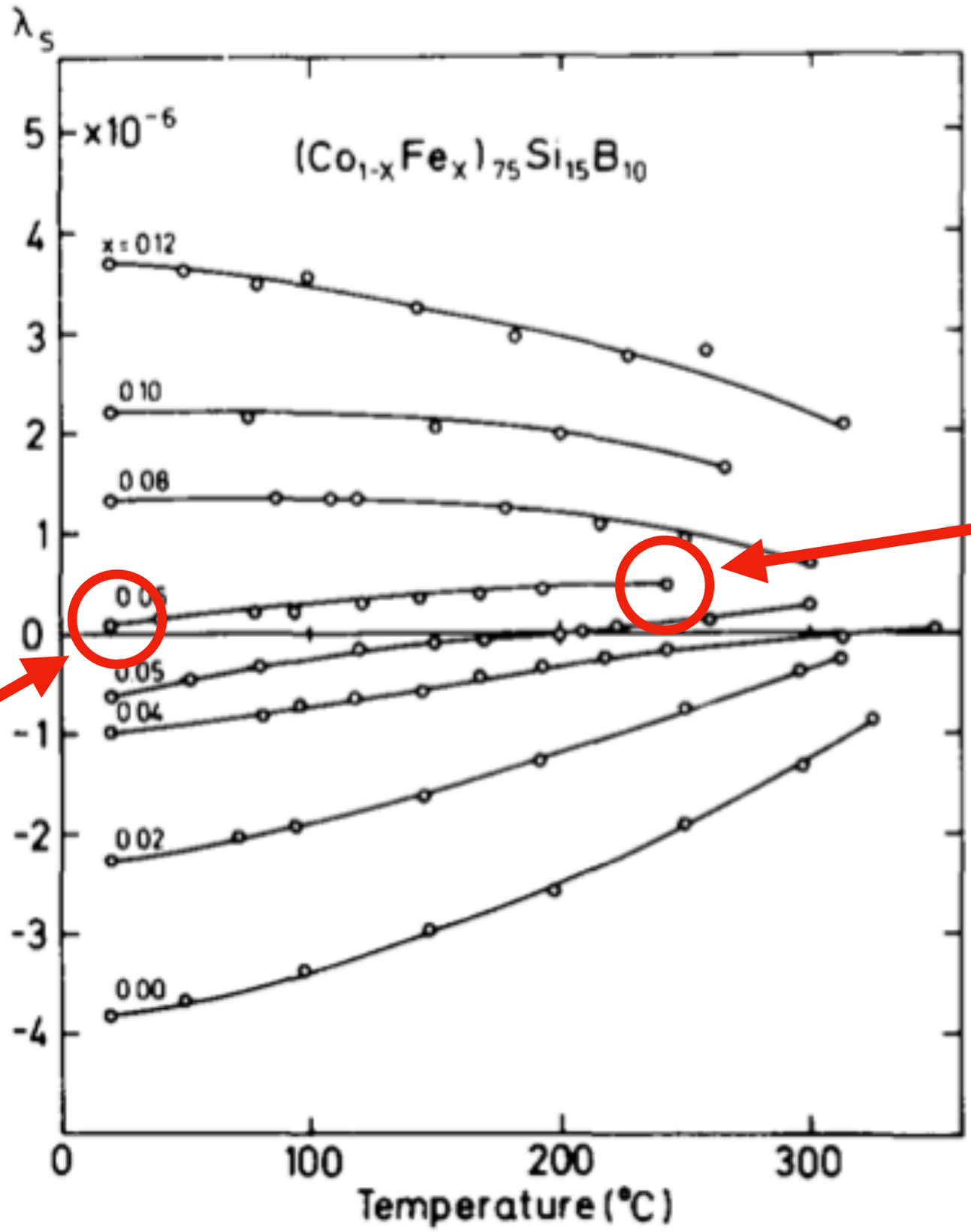
At Fe = 6 %

The mechanical stress does not increase the noise.

At room temperature…

A better composition for magnetic microwires? Playing with cobalt and iron.

You use the sensor here…

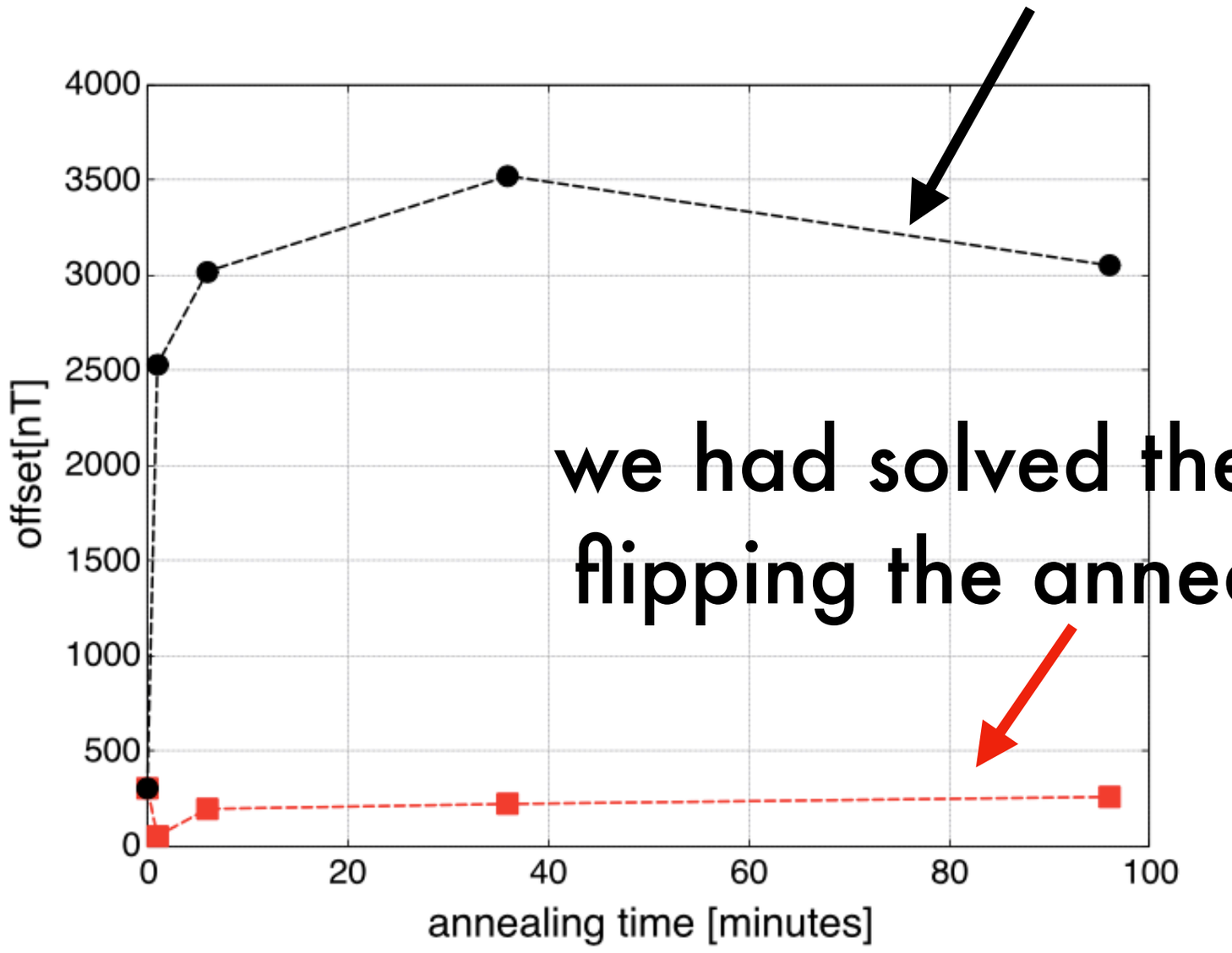


…but during annealing you are here

During annealing magnetostriction is NOT vanishing

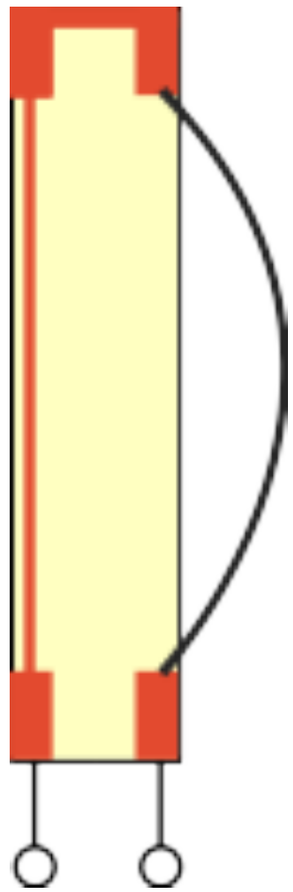
If the wire is straight or bent… matters!

During annealing with straight wire offset increase… a lot!



we had solved the problem by flipping the annealing current

Annealing a curve wire



The offset does not increase if we anneal with naturally bent wire

(yes, even without flipping the current)

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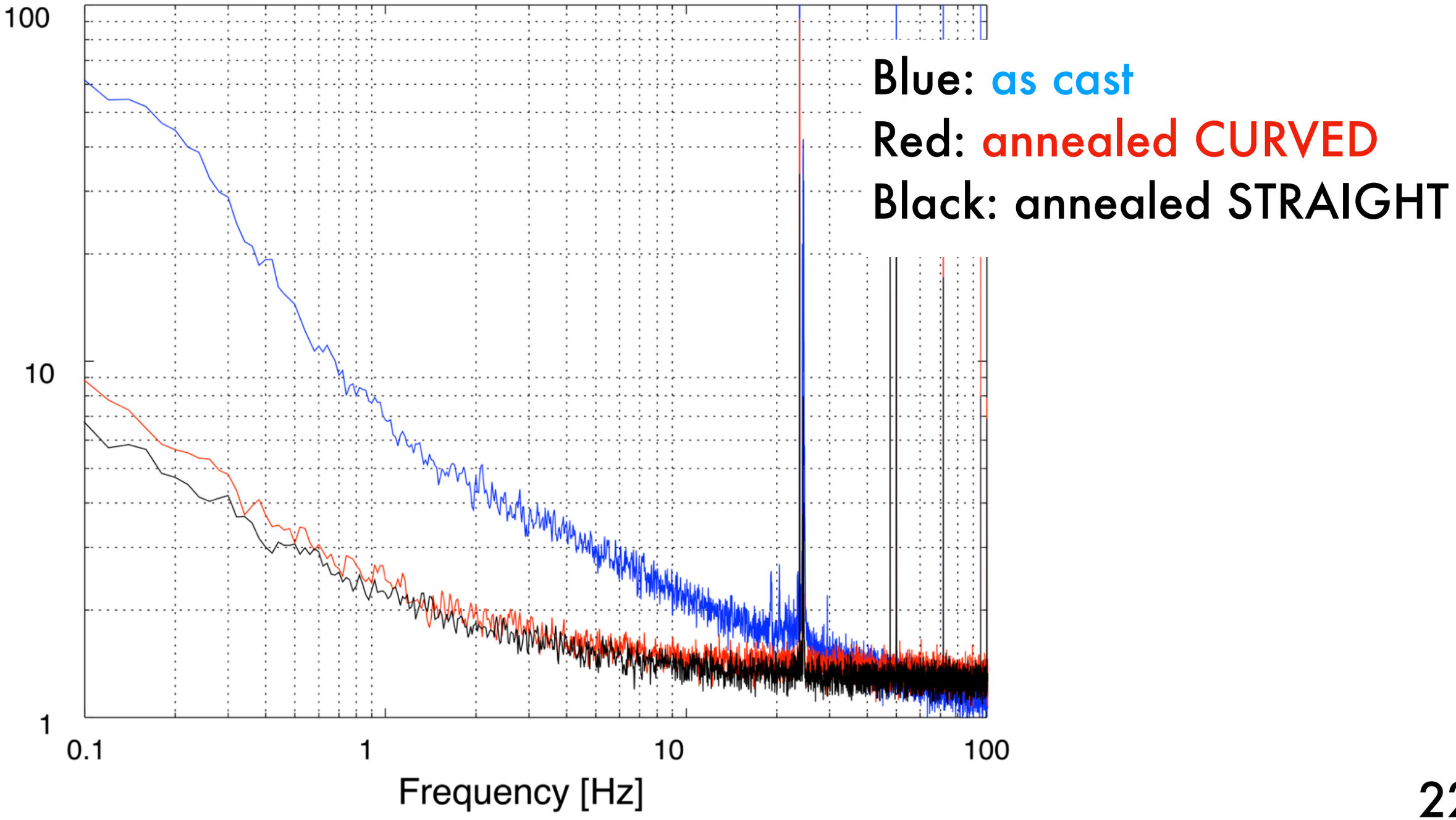
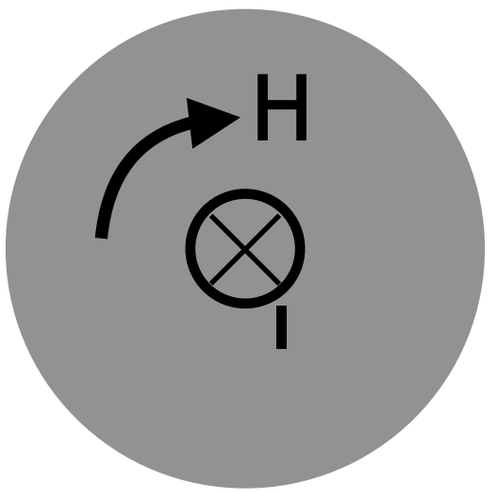
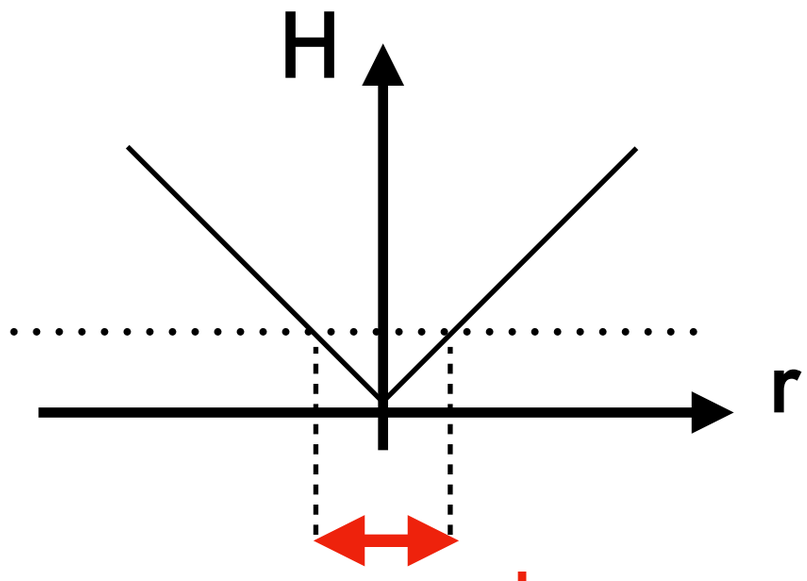


Other sources of noise?

cross-section of the wire



min. H to saturate



Casting of wires with non-magnetic core

Let's add copper!

CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

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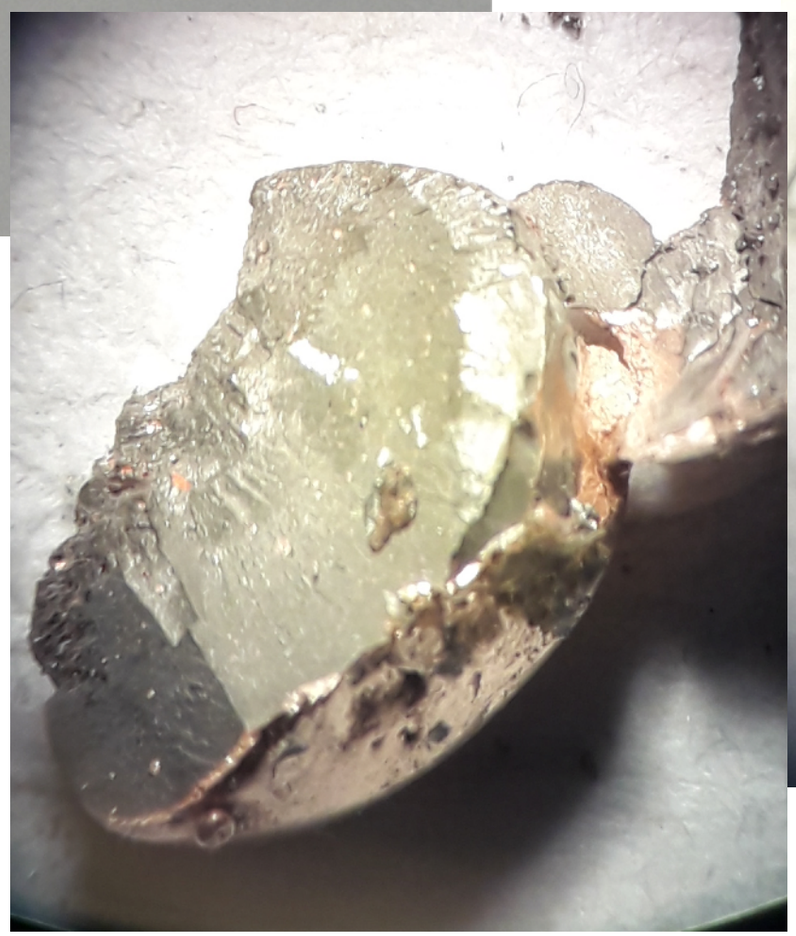

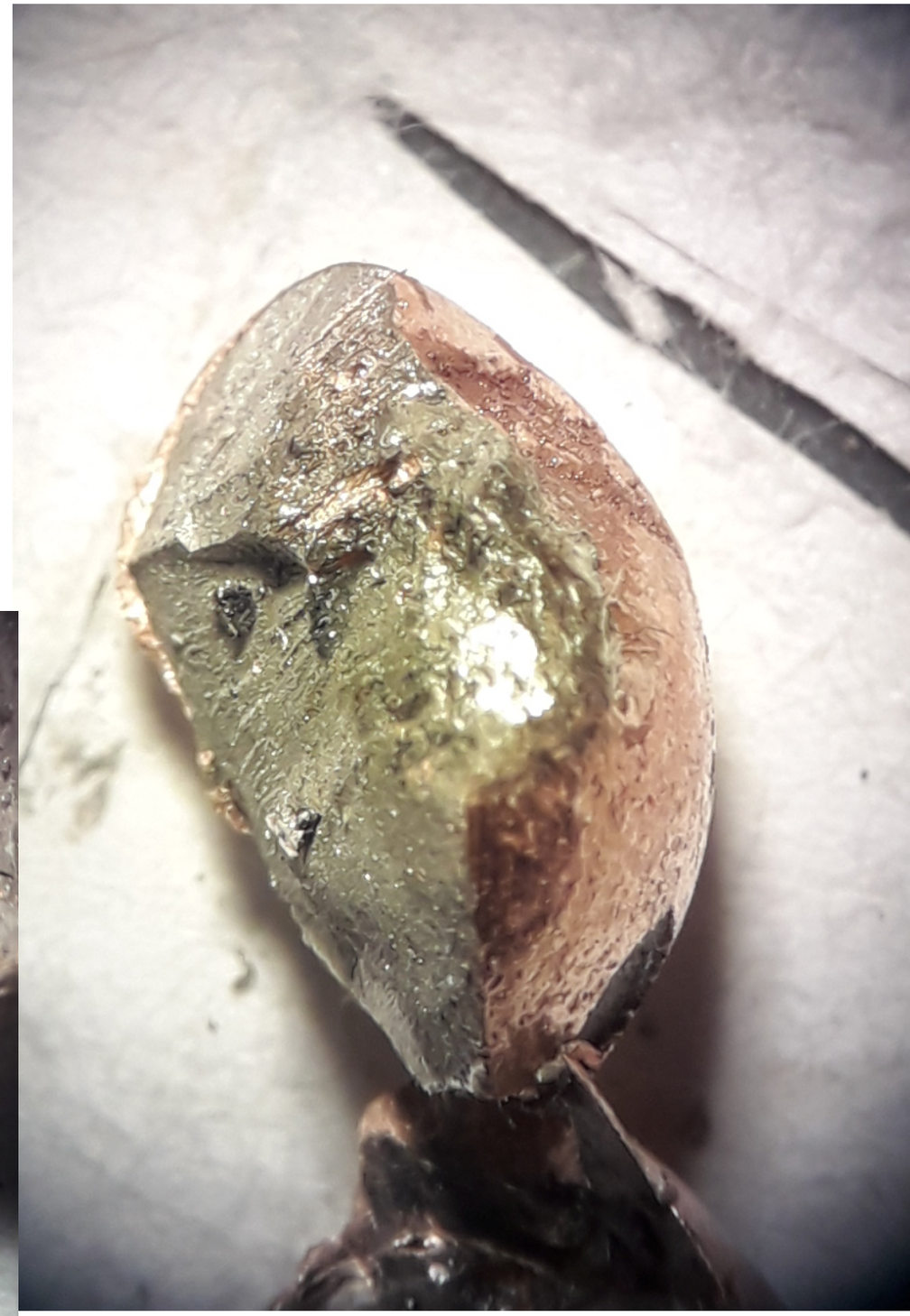

failure!

what's next?

Journal of Magnetism and Magnetic Materials 53 (1986) 323–329
North-Holland, Amsterdam

INDUCED MAGNETIC ANISOTROPY AND CHANGE OF THE MAGNETOSTRICTION BY CURRENT ANNEALING IN Co-BASED AMORPHOUS ALLOYS

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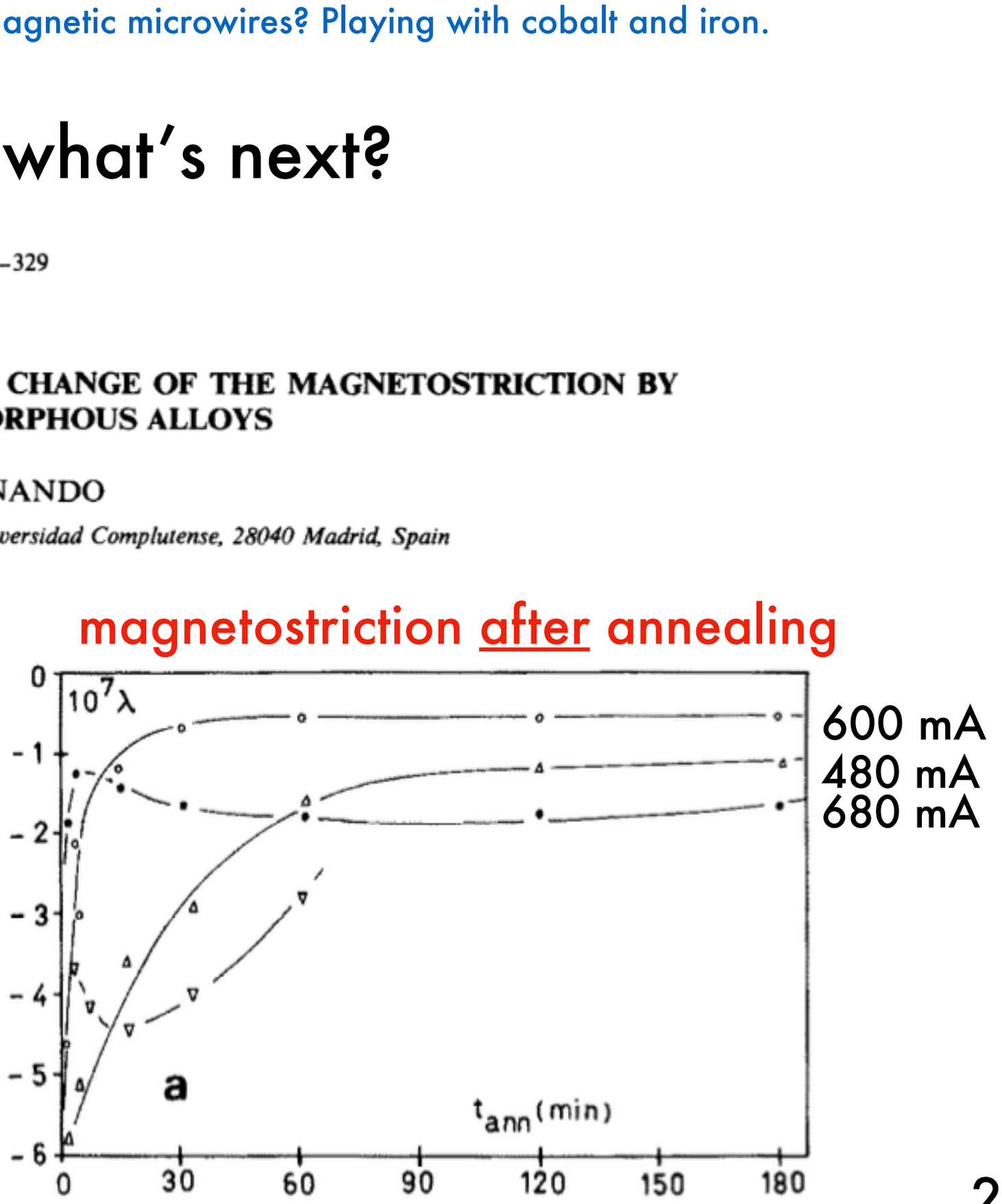
Laboratorio de Magnetismo, Facultad de Ciencias Fisicas, Universidad Complutense, 28040 Madrid, Spain

Received 1 July 1985; in revised form 29 July 1985

$(Co_{0.95}Fe_{0.05})_{75}Si_{10}B_{15}$

magnetostriction after annealing



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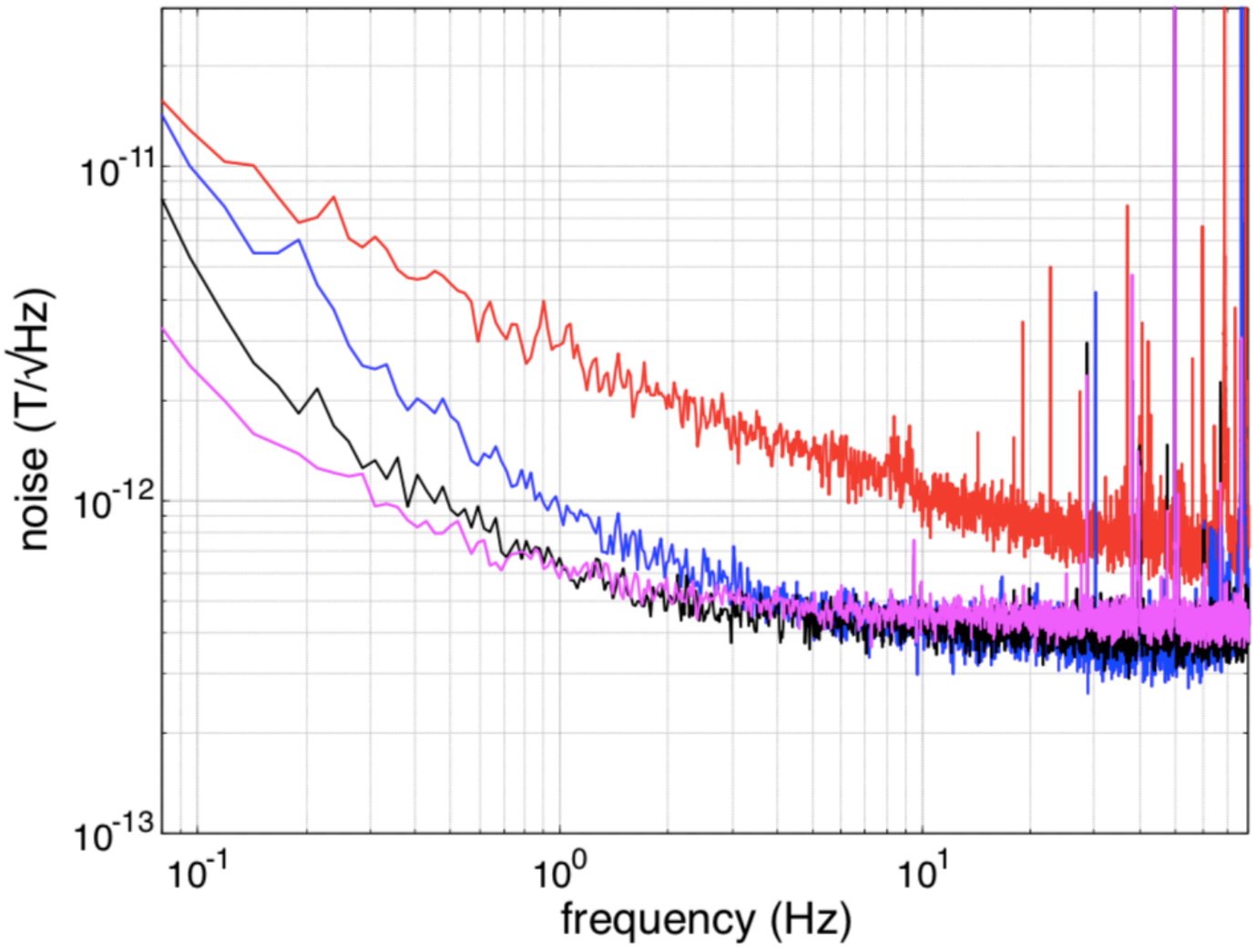

annealing time

as cast

1 minute

11 minutes

21 minutes

Should we start from
slightly negative magnetostrictive wires
and then anneal them?

Thank you for your attention

Acknowledgement to:

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International Mobility of Researchers in CTU

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