Last coating Q measurements at MIT

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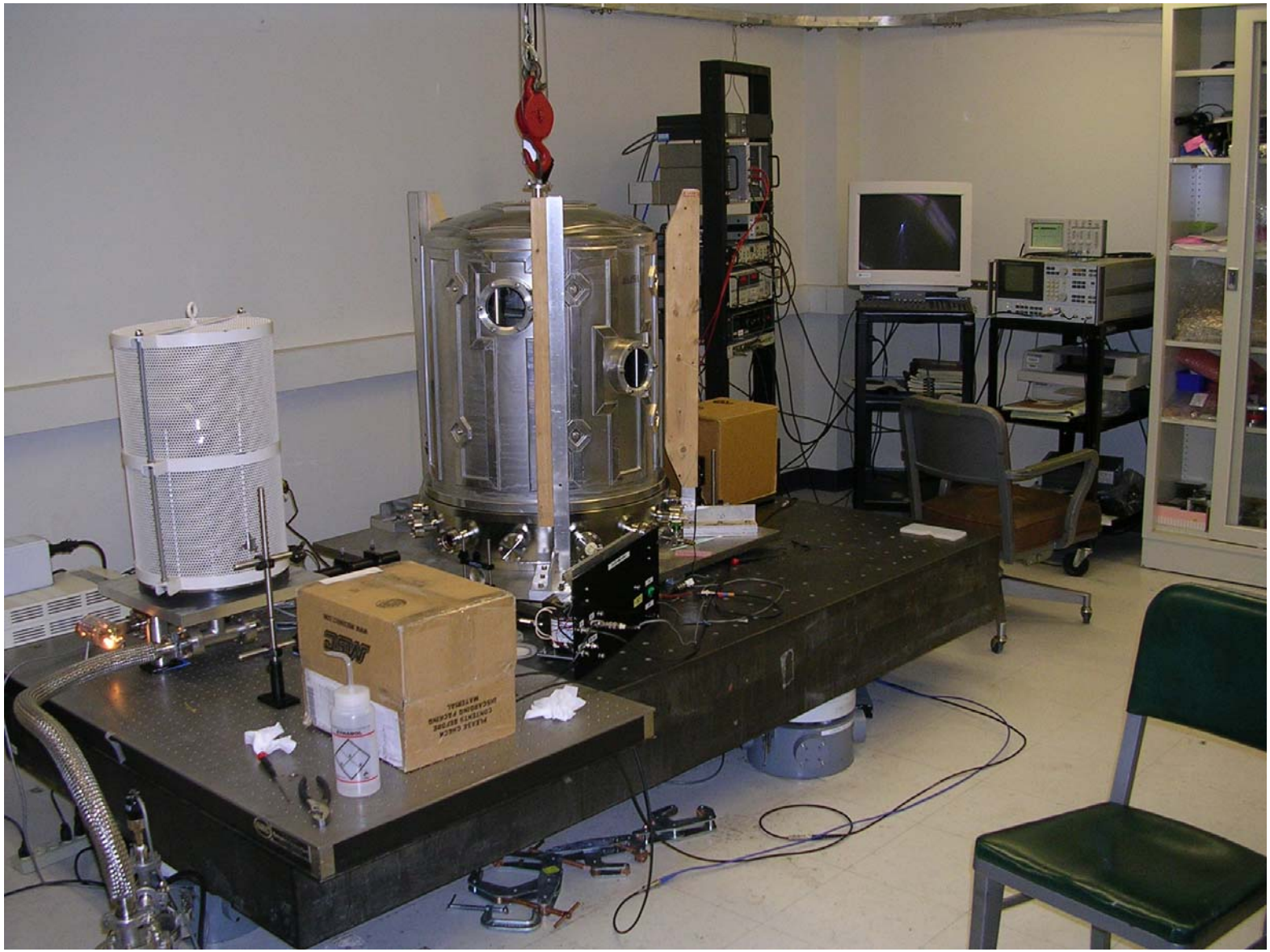
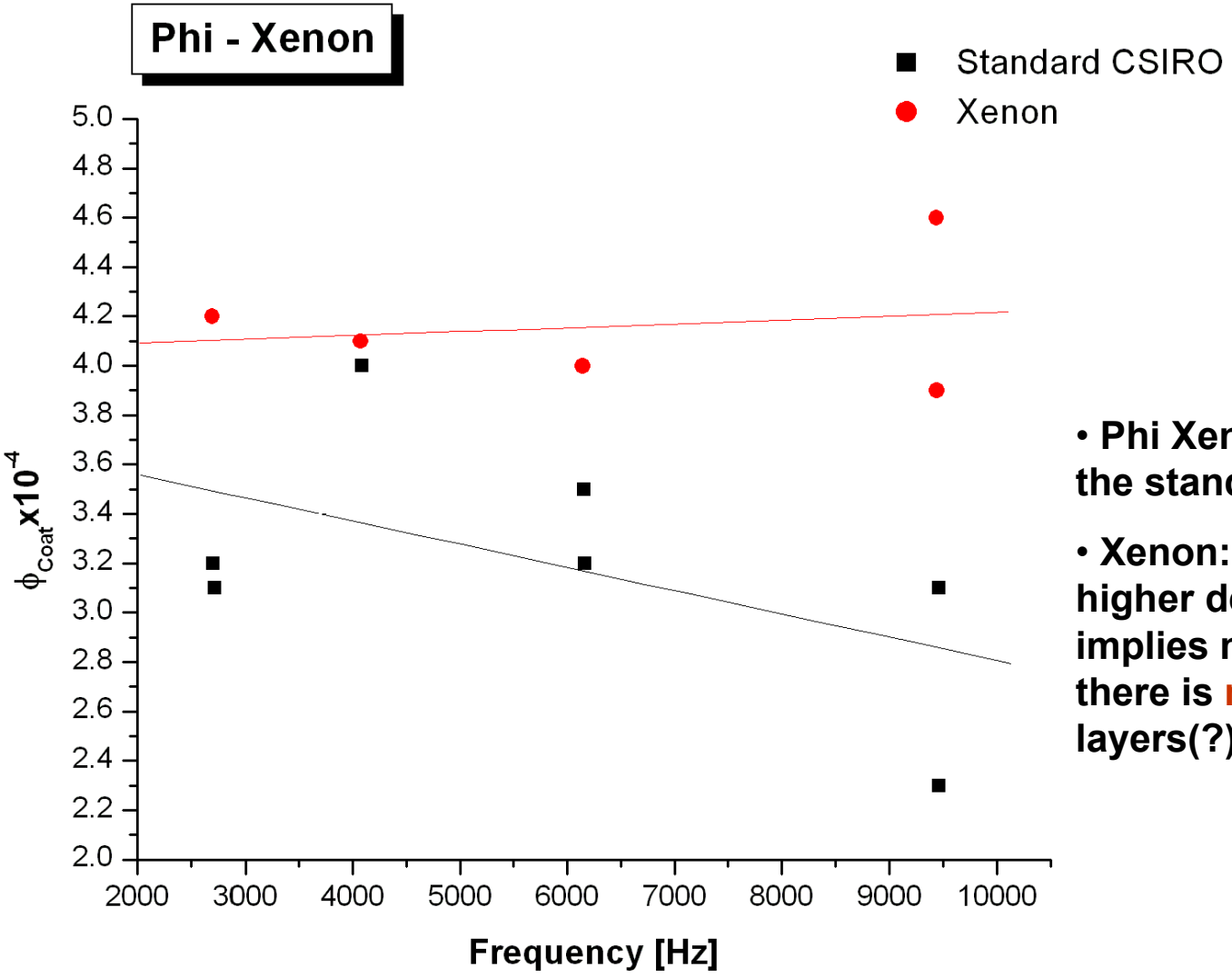


Review last coating measuments
(CSIRO Coating)

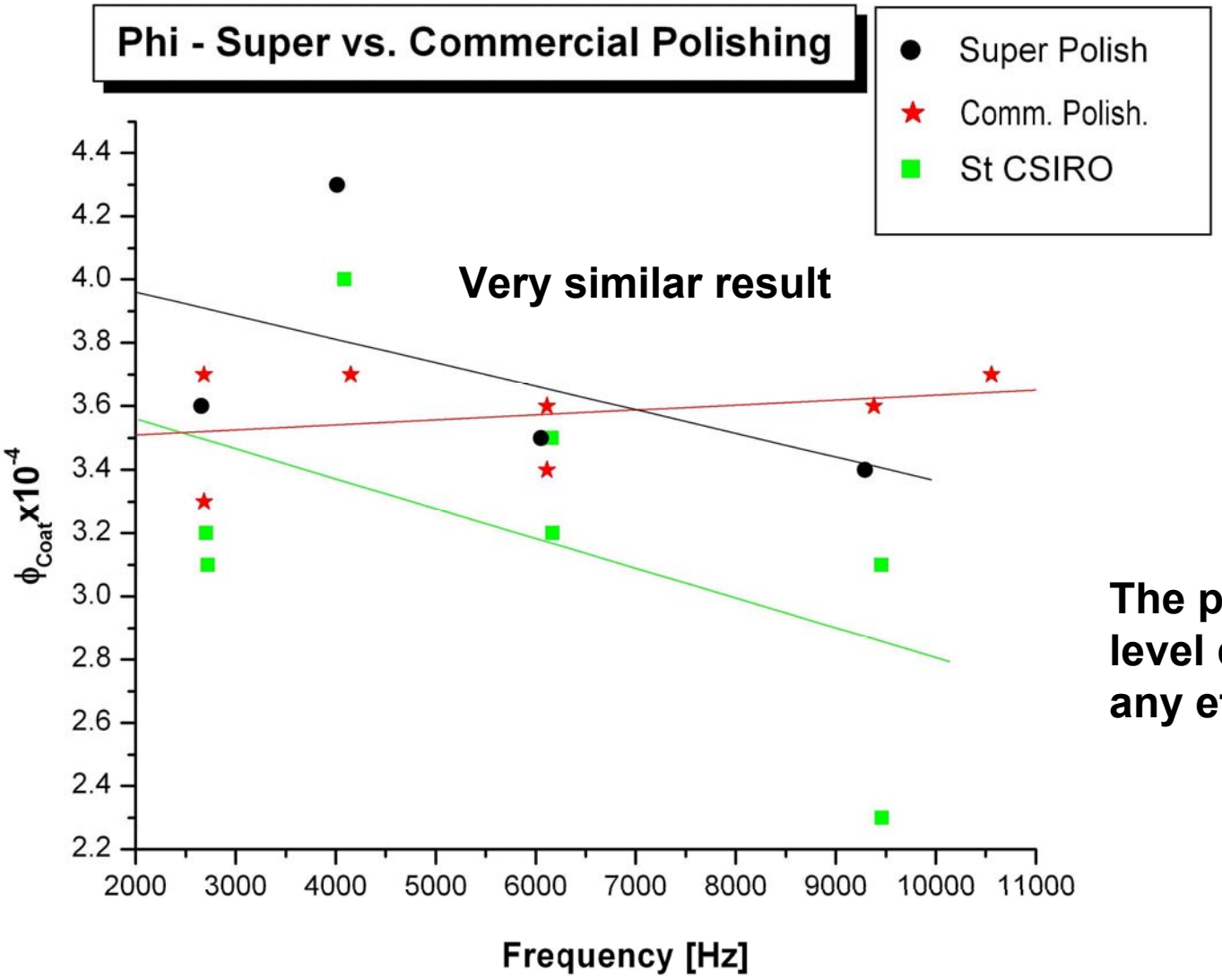
- Xenon
- Commercial Polishing
- Super Polishing
- Pure Tantala 1.8μm
- Pure Tantala 4μm (Preliminary data)
- Quality Factor vs. Temperature Experiment

Xenon



- **Phi Xenon a bit higher than the standard value**
- **Xenon: sample with a higher density coating implies more loss because there is more material in the layers(?)**

Comm. & Super Polish.

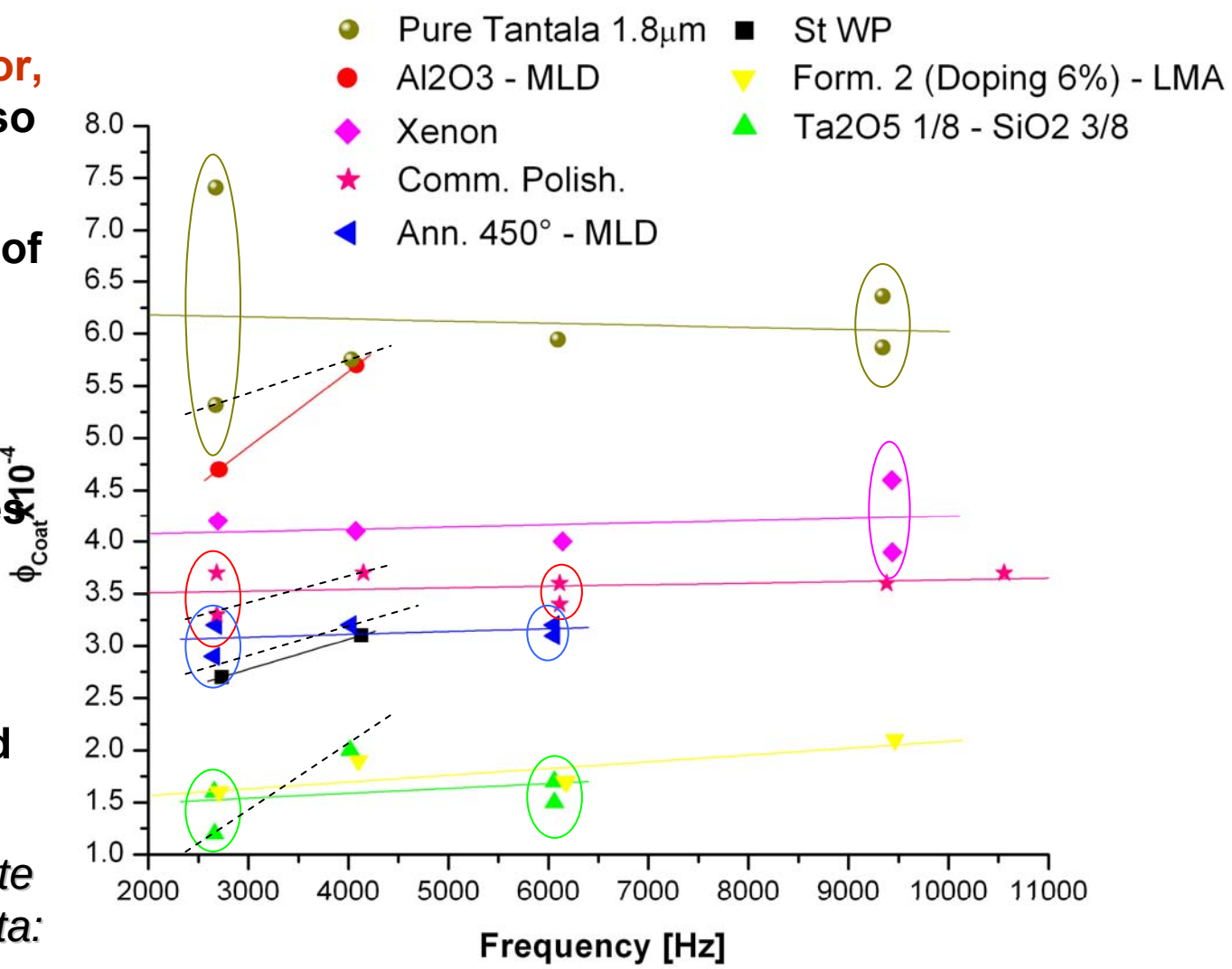


The polishing at this level doesn't have any effect

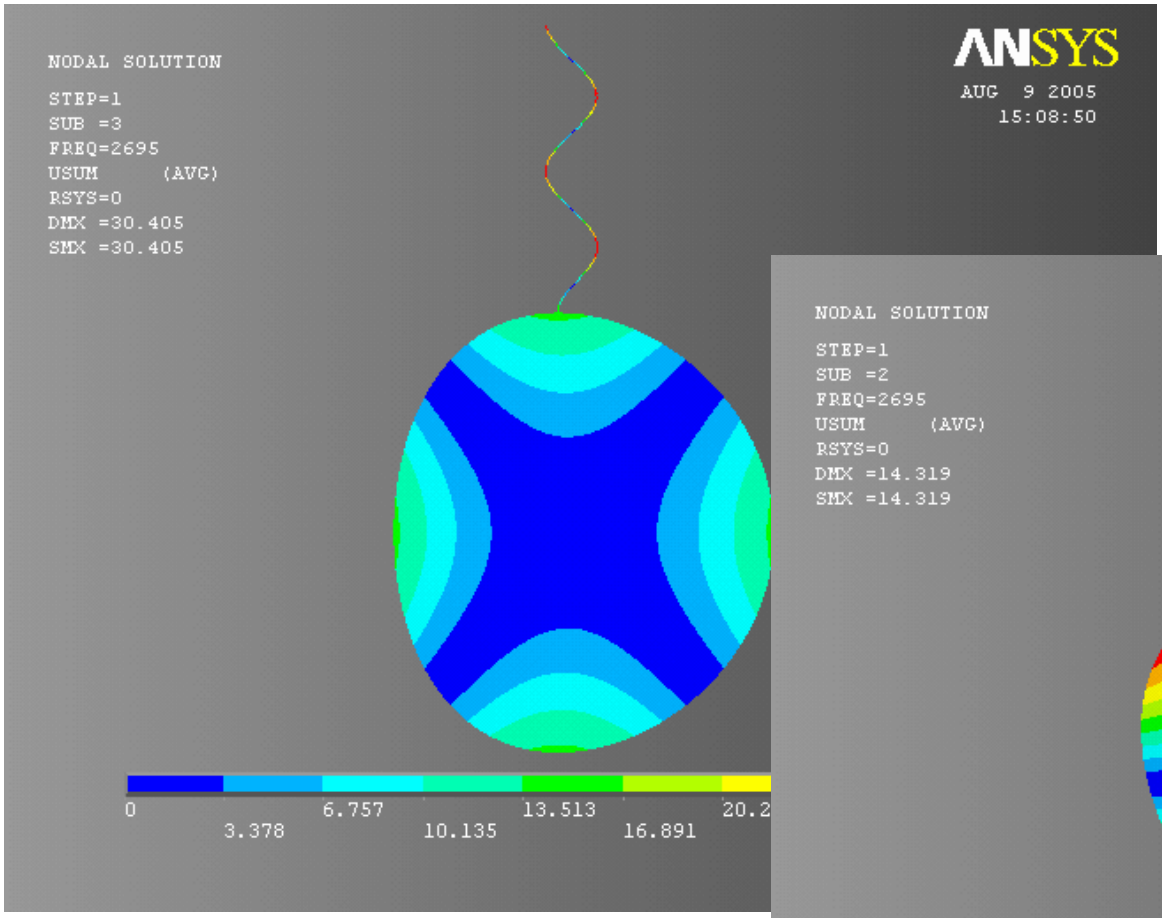
Pure Tantala 1.8µm (1/4)

- **Different results depending on the vendor, annealing, doping and so on**
- **Separation for the phi of the double modes - standard behaviour exacerbated in tantala sample: mirror/fiber coupling or asymmetries in the mirror or coating**
- **Drum mode is always higher: error on the energy ratio or standard behaviour?**

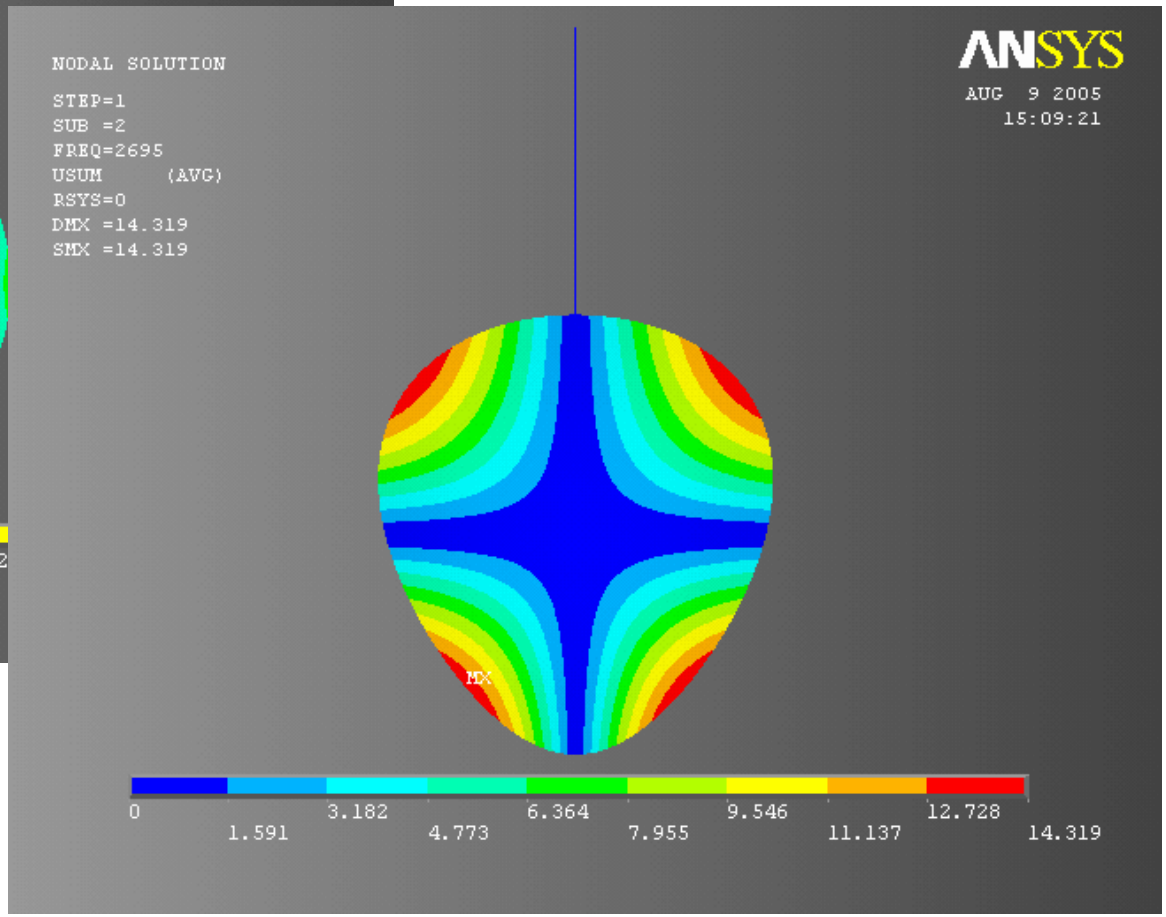
(PS: Lines only to separate the different groups of data: lack of higher data)



Pure Tantala 1.8μm (2/4)

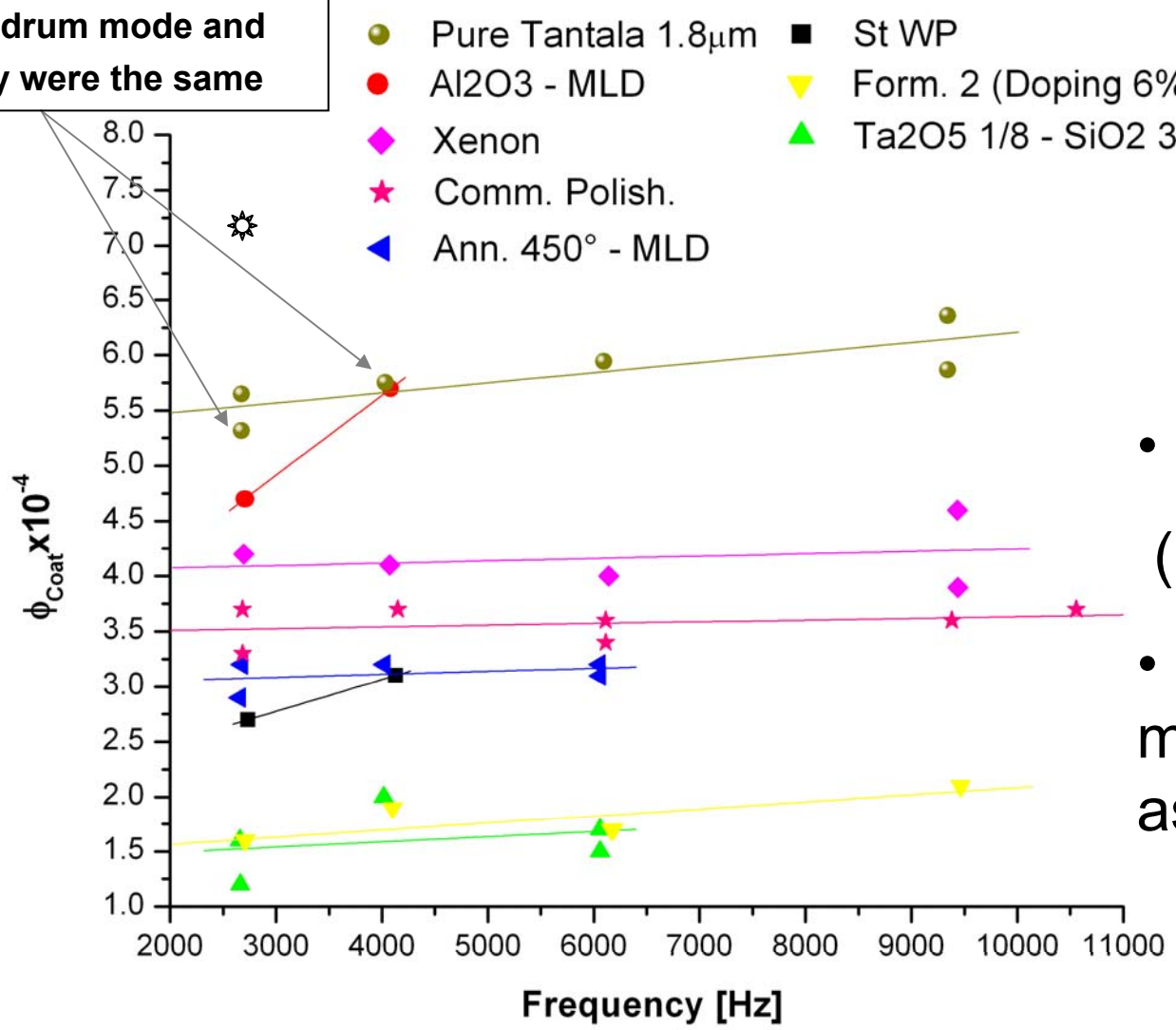


First butterfly double mode



Pure Tantala 1.8µm (3/4)

Check on the 2nd freq. of the 1st Butt. and on the drum mode and they were the same



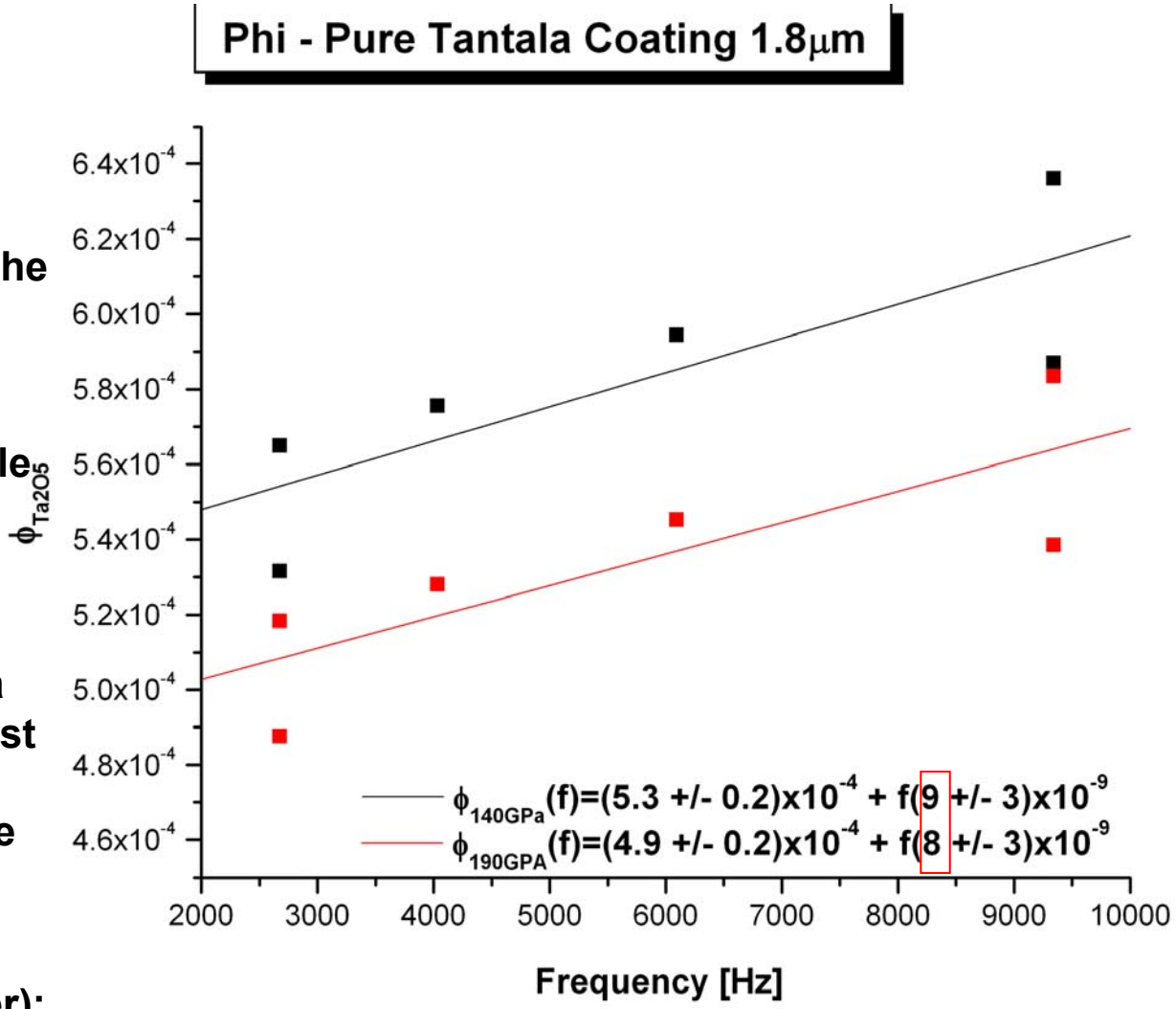
- Range of Φ_{coat}:

  $(1.2 – 4.1) \times 10^{-4}$

- Residual separation maybe due to some asymmetry

Pure Tantala 1.8μm (4/4)

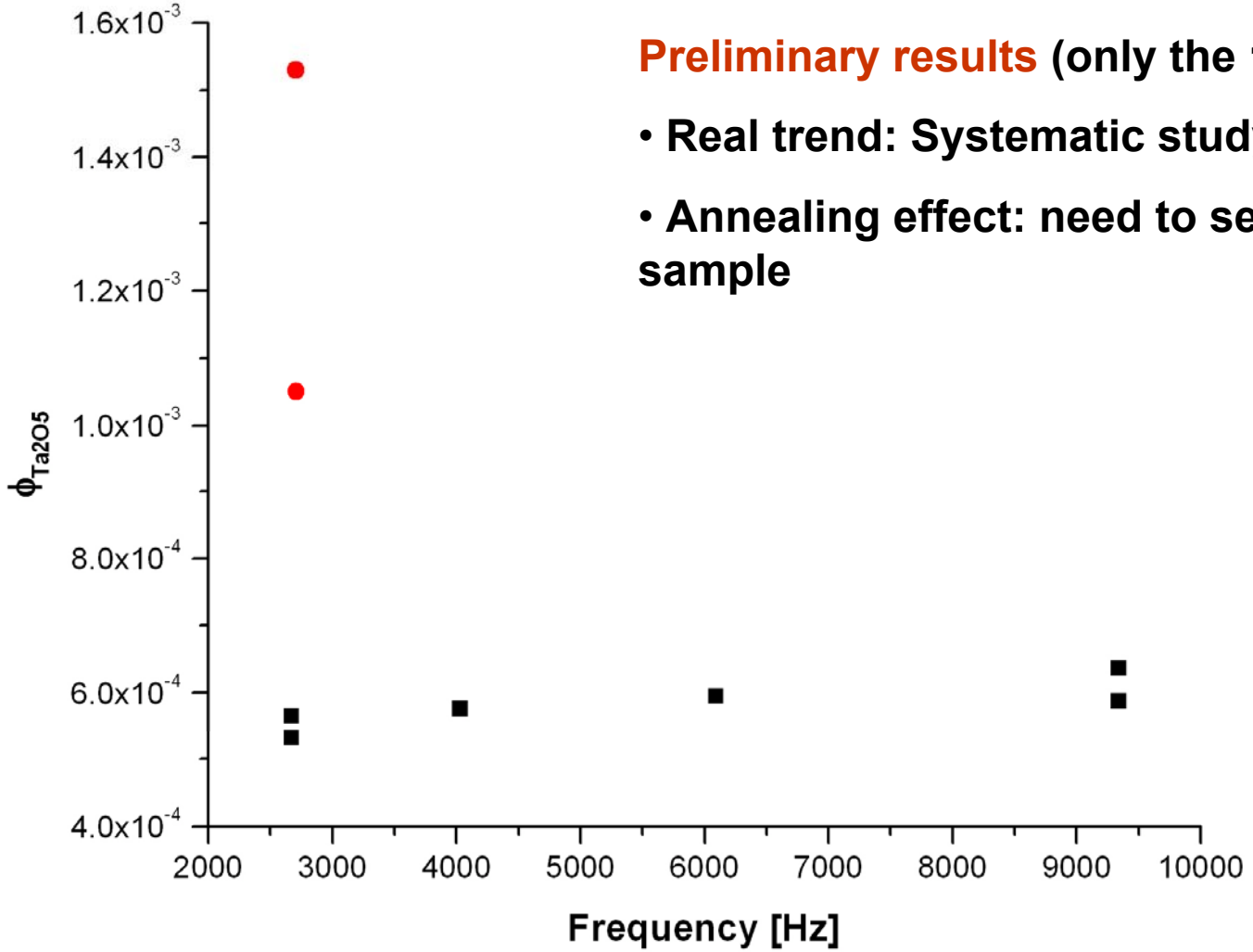
- It's extremely important have the correct value for the Young modulus: 120, 140 or 190 GPa for the tantala?
- From previuos plot: Do the mechanical properties depend on the deposition parameters? We need to decide what kind of sample we want and measure the MP of each of them
- New value (CSIRO-monolayer): the slope is a factor 4 higher than the last measurement through a multilayer coating - maybe due to the lack of high frequency data (Y-conn.)
- Old value (LMA-multilayer):



$$\phi_{Ta2O5} = (4.3 \pm 0.2) \times 10^{-4} + f\,(2.0 \pm 07) \times 10^{-9}$$

$$\phi_{Ta2O5} = (4.2 \pm 0.2) \times 10^{-4} + f\,(0.4 \pm 0.5) \times 10^{-9}$$

Pure Tantala 4µm

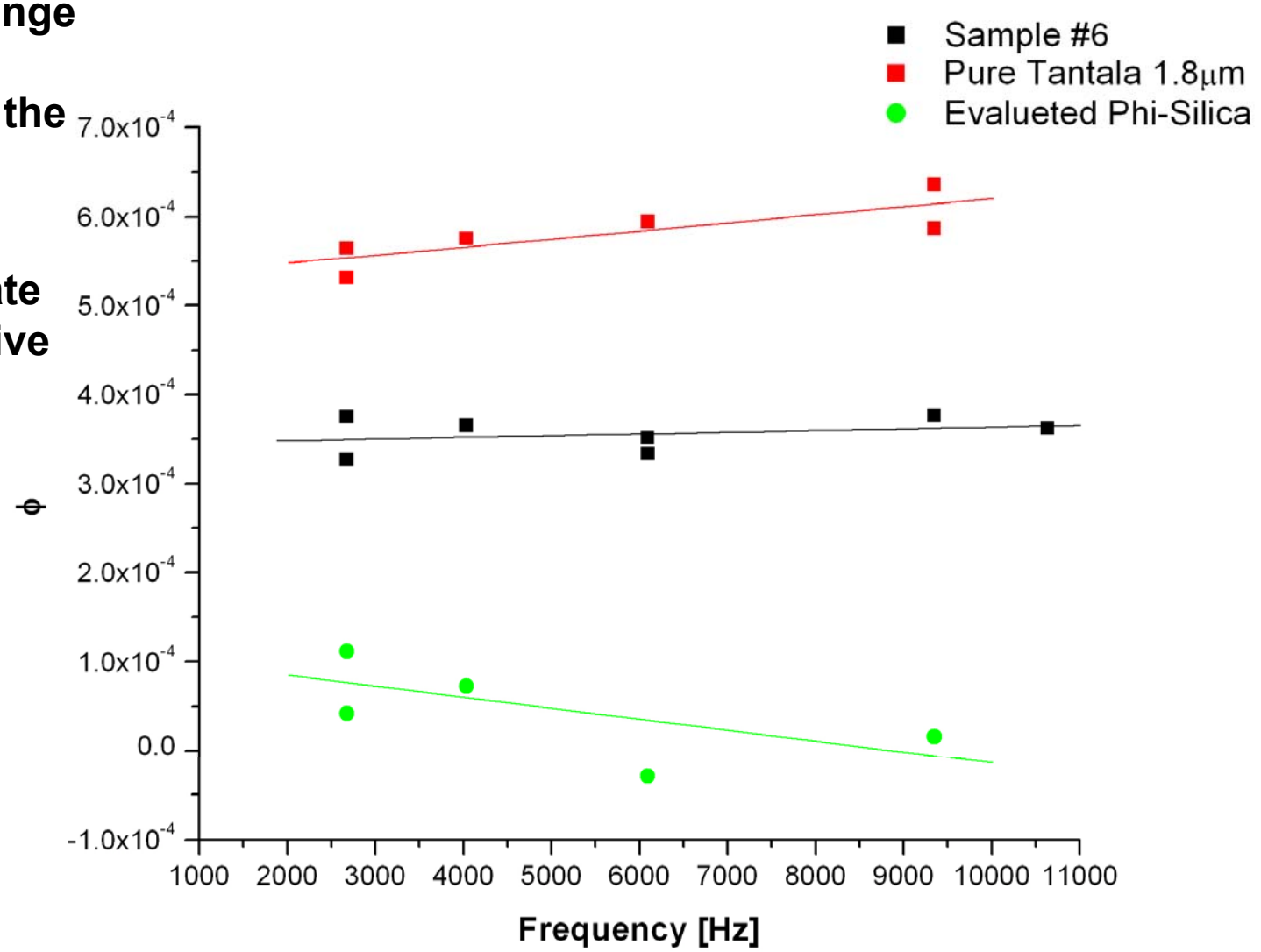


Preliminary results (only the 1st Butterfly mode)

- **Real trend: Systematic study Φ_{coat} vs. thickness**
- **Annealing effect: need to see the next annealed sample**

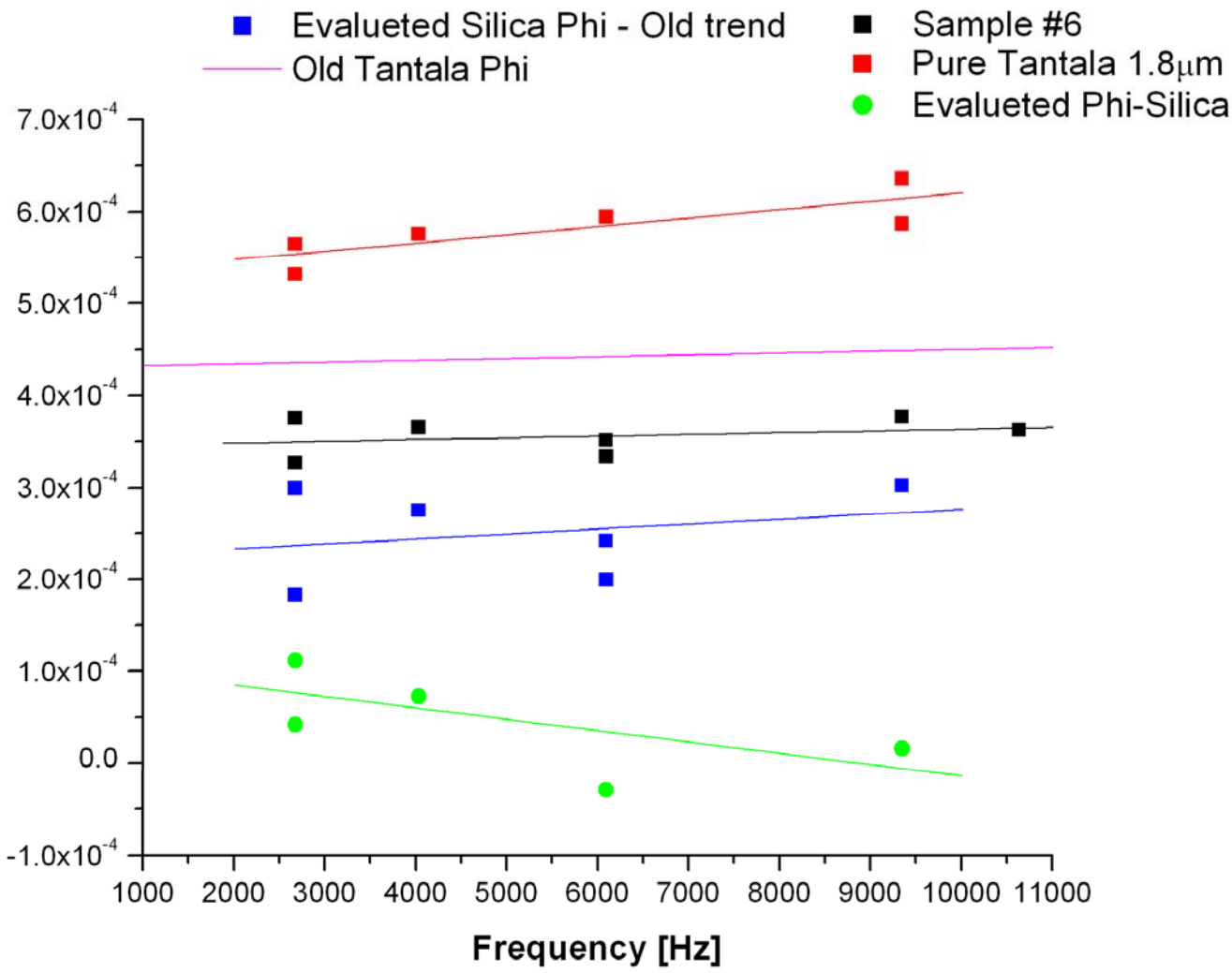
Silica Phi (1/2)

- **Because of the change in the Φ_{coat} we "can" (maybe "must") use the tantala phi only with CSIRO sample**
- **Difficulty to calculate the Silica Phi: negative slope and values**



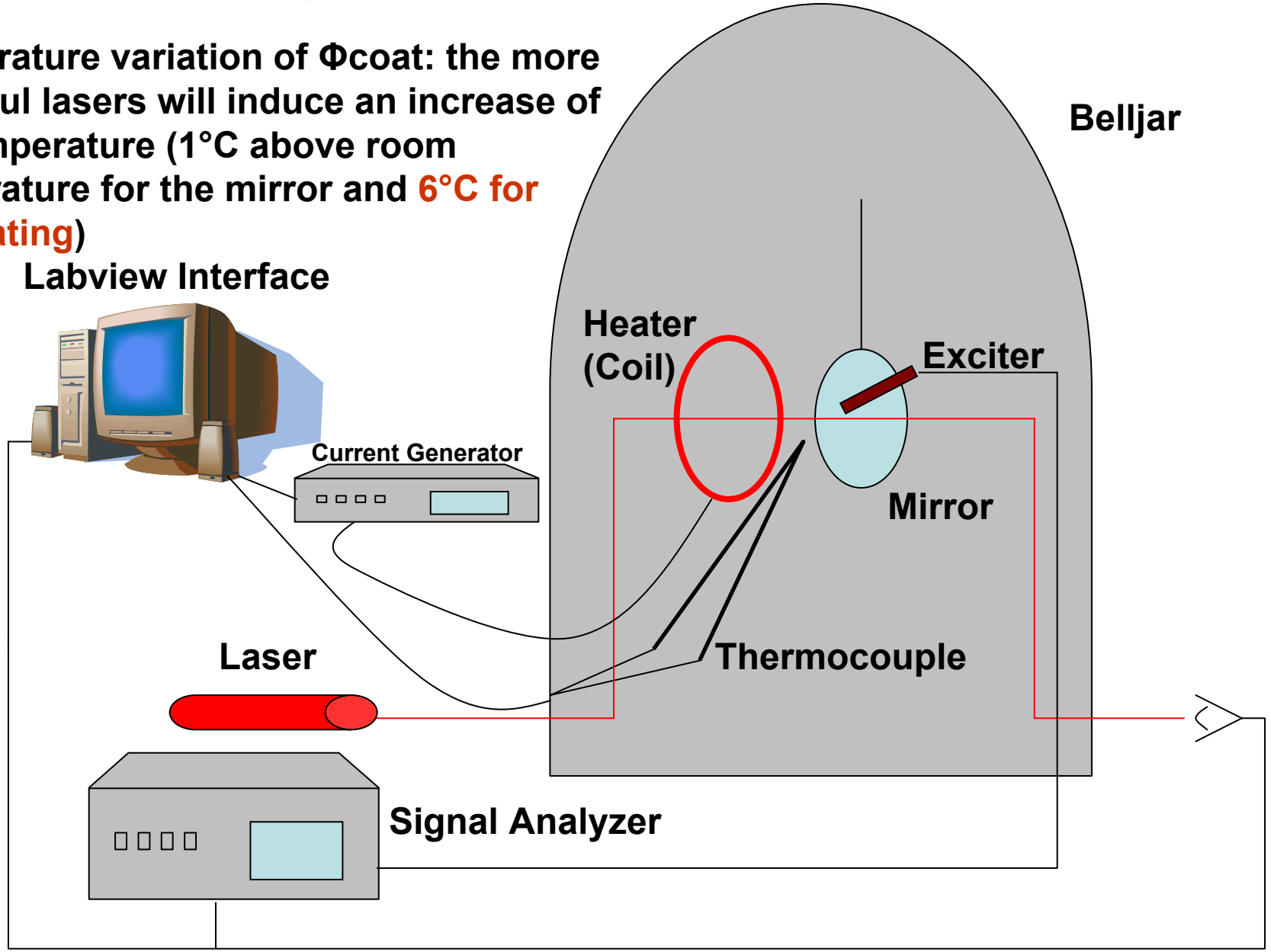
Silica Phi (2/2)

- **Just for fun I used the old tantala data: maybe wrong Φ_{Ta2O5} value because of dependence on thickness or annealing (?)**
- **Possible ideas to calculate**
  - **Φ_{Ta2O5}: Thick. or anneal. (Next sample should give a direction)**
  - **Φ_{SiO2}: New sample (silica on sapphire or silica on silica)**



Frequency vs. Temperature System (or Matt's Experiment)

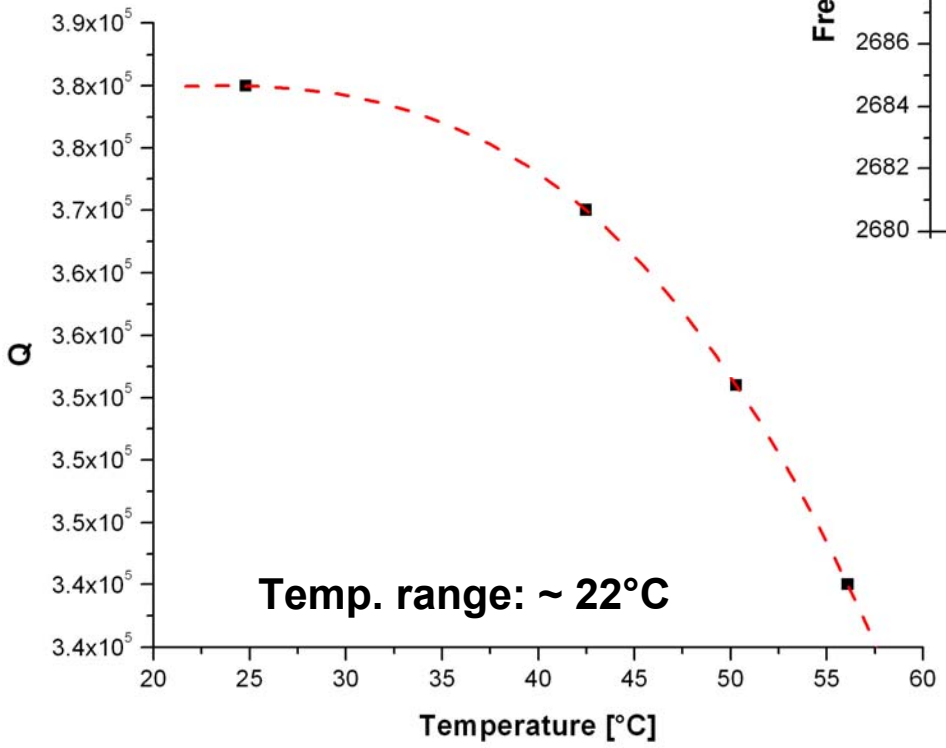
Temperature variation of Φcoat: the more powerful lasers will induce an increase of the temperature (1°C above room temperature for the mirror and 6°C for the coating)

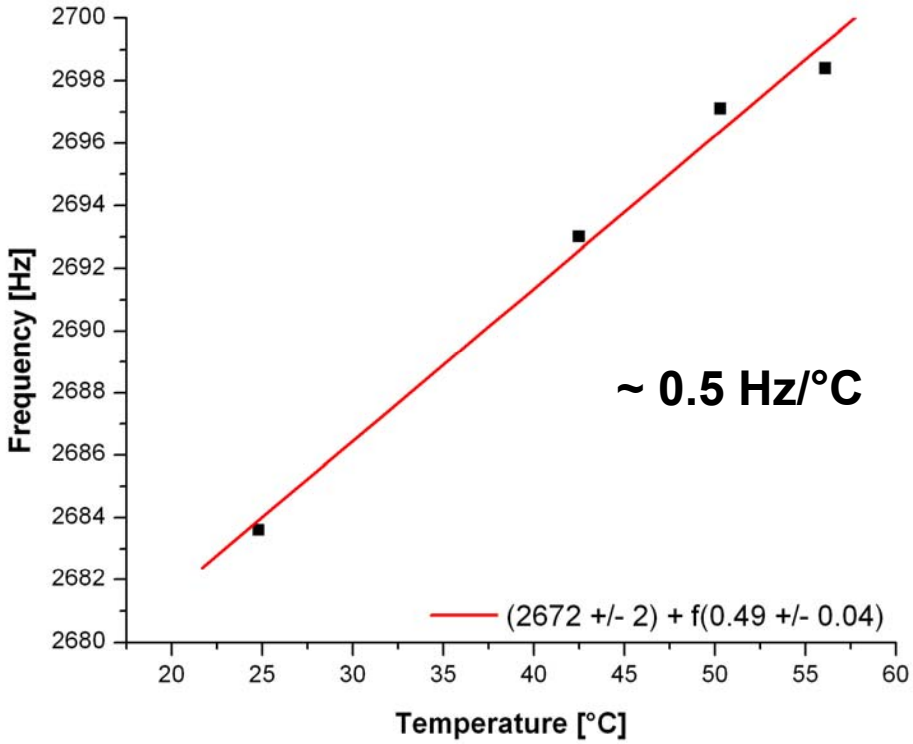


Q. vs. Temp. 1ST Result

Freq. & Q vs. Temp. Results

- Q decreased with incresing the temperature: clear trend
- Uncoated sample to calculate the coating effect
- To see if there is a real trend we need to increase the temperature range: new system (?)





Possible reasons:

- Substrate effect (uncoated sample)
- Different coupling mirror/fiber or mirror/asimmetries: need much more data
- Real change of the sub/coat Q

Old Data (1/2)

- Range of Φ_{coat}: 1.2-4.7 x 10^{-4}
  - Relative Thermal Noise variation: about a factor 2 $(S_x \propto \sqrt{\phi_{coat}})$
- Samples that have more oxygen and less oxygen: a bit higher Φ_{coat}
  - Less oxygen sample was not annealed (being done at Stanford)
- Polishing: no difference between commercial and super polishing

Old Data (2/2)

- Xenon: a bit higher Φ_{coat}
- Doping: Good improvement
- Other material
  - Alumina: a bit higher Φ_{coat}
  - Niobia: standard value
- Reduction of tantala thickness: good result
- Annealing: No consistent data
- Young modulus: New measurement
- Tantala and Silica Phi: more data
- Q vs. Temp. Exp: more data

THE END